

CONTOUR TONE DISTRIBUTION IS NOT AN ARTIFACT OF TONAL MELODY MAPPING*

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In traditional autosegmental analyses of tone, the gravitation of contour tones to prosodic-final syllable and syllables in shorter words is conceived as the result of the one-to-one, left-to-right Association Conventions that govern the mapping of tonal melodies. I argue in this paper that these properties of contour tone distribution are not an artifact of melody mapping, but stem from the longer duration of these syllables. Three arguments are presented: first, there are languages that do not justify tonal melodies, but have the same kinds of restrictions on contour tone distribution; second, even in languages with justifiable melodies, an Optimality-Theoretic rendition of the mapping mechanism still requires the identification of syllables with greater duration as privileged contour bearers; third, the lack of contour tone advantage in initial position has to be arbitrarily posited as the result of directionality by the mapping analysis, but receives a principled account in the durational approach, as initial position does not benefit from lengthening comparable to final position. This paper complements Zoll (2003)'s theory of Optimal Tone Mapping in presenting additional arguments against tonal melody mapping and putting the distribution of tones in the bigger context of phonology-phonetics relationship.

1. Introduction

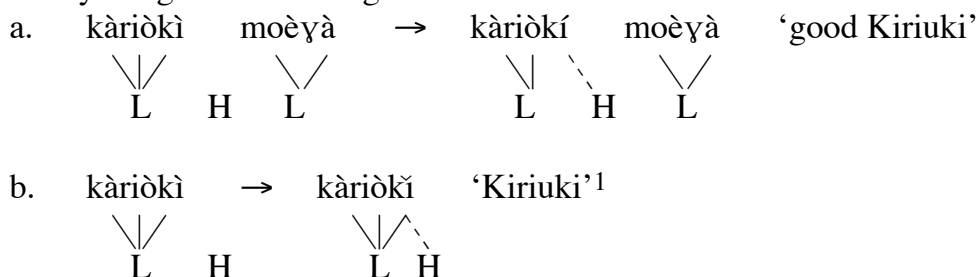
The phonological status of contour tone has been widely disputed over the past decades. It is often argued that contour tones in Asian languages are different from those in African languages, in that the former form a tonal unit while the latter are

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tonal clusters. My use of the term ‘contour tone’ here does not make the unit vs. cluster distinction and consequently includes any pitch change within a syllable that has a contrastive function, lexical or grammatical. I am concerned here mainly with the distribution of contour tones in a language, i.e., under what phonological contexts contour tones are more readily realized. The topic has been of much theoretical interest, as it sheds light on the representation of tone (Woo 1969, Bao 1990, Duanmu 1990, 1994a, Yip 1989, 1995), the mechanism of tonal association (Leben 1973, Goldsmith 1976, Clements & Ford 1979, Pulleyblank 1986, Yip 1988, Zoll 2003), and the relation between phonetics and phonology (Duanmu 1994b, Gordon 1999, Zhang 2000a, 2002).

One characteristic of contour tone distribution is that contour tones often occur more freely in prosodic-final positions. This is explicitly noted in Clark (1983). One example she cites is Kikuyu (based on Clements & Ford 1979): when a floating High tone docks onto a syllable with an original Low tone, a simple High tone obtains if the syllable is not phrase-final (1a); but a LH rise surfaces if the syllable is phrase-final (1b).

(1) Kikuyu High tone docking:



Clark’s intuition has proven valid cross-linguistically by a survey of contour tone distribution documented in Zhang (2002). Of the 187 languages surveyed, 47 languages distributed in different language phyla, from Afro-Asiatic and Niger-Congo to Oto-Manguean and Sino-Tibetan, show the preference for phrase-final syllables as contour bearers. The preference is established through the following criteria: (a) contour tones can occur on a final syllable but not on the same syllable elsewhere; (b) the contour tones that occur on a final syllable are a superset of those that occur on the same syllable elsewhere; and (c) the pitch excursions of contour tones on a final syllable are greater than those on the same syllable elsewhere.

My survey also reveals another characteristic of contour tone distribution, namely, the preference for contour tones to occur on syllables in words with a lower syllable count. Such preference is established through the same criteria outlined above. 19 genetically diverse languages show this preference.

¹ Clements and Ford (1979) argue that there is also a floating extra low after the floating high for the word. The extra low is not realized in either of these forms.

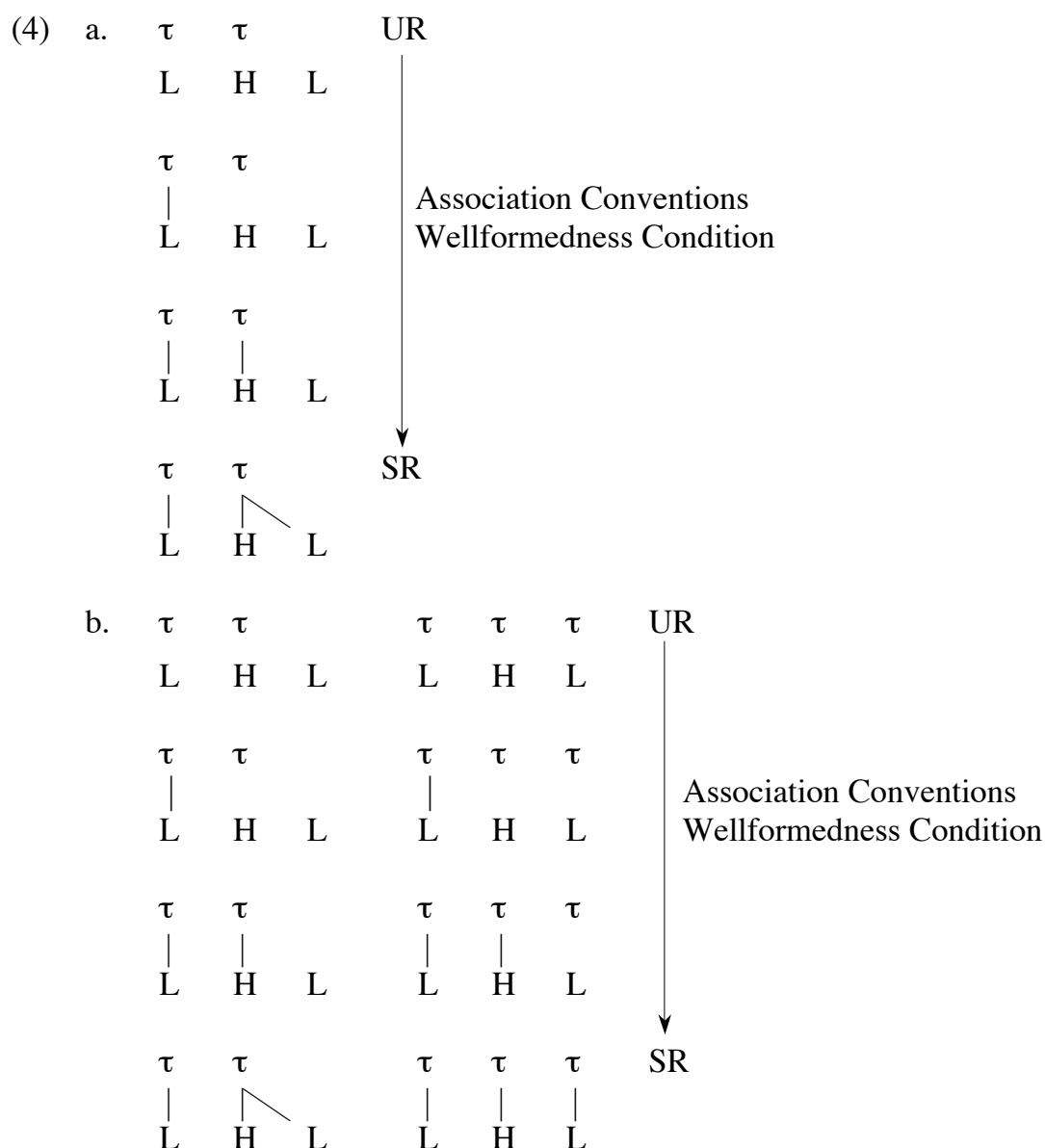
Shanghai Chinese illustrates the contour tones' preference to occur in shorter words. As a Northern Wu dialect of Chinese that is often described as having a 'left-dominant' tone sandhi pattern (Yue-Hashimoto 1987), its basic sandhi pattern is that the tone on the initial syllable of a polysyllabic compound spreads rightwards, taking over the lexical tones of other syllables. This is schematized in (2) (Zee & Maddieson 1979). As we can see, the HL pattern fits the above description neatly; but the LH pattern involves a slight complication — there is a boundary Low tone at the right edge of the sandhi domain, and the tones on syllables between the spread H and the boundary L are interpolated between the H and the L. Despite the complication, the following generalization holds: monosyllabic words may have contour tones in isolation in Shanghai, but no contour surfaces in polysyllabic compounds.

(2) Shanghai tone sandhi:

σ_1	$\sigma_1\sigma$	$\sigma_1\sigma\sigma$	$\sigma_1\sigma\sigma\sigma$
HL	H-L	H-M-L	H-M-L [↑] -L
MH	M-H	M-H-L	M-H-M-L
LH	L-H	L-H-L	L-H-M-L

In traditional autosegmental theory of tone, there is an easy explanation for the greater contour tone licensing ability of prosodic-final syllables and syllables in shorter words. Assuming that tones and tone-bearing units (TBUs) are linked according to the Association Conventions and Wellformedness Condition (Leben 1973, Goldsmith 1976, Pulleyblank 1986) as in (3), the gravitation of contour tones to final syllables is an artifact of the left-to-right mapping direction, and the privilege of syllables in shorter words is an artifact of tonal melodies. The derivation in (4a) shows that if left-to-right mapping is a phonological universal, contour tones will only surface on the right edge of a prosodic domain, and the derivation in (4b) shows that the faithful realization of a tonal melody may result in contour tones in a shorter word, but not in a longer one.

- (3) a. Association Conventions: Map a sequence of tones onto a sequence of tone-bearing units from left to right, in a one-to-one relation.
- b. Wellformedness Condition: Association lines do not cross.



This formal explanation, however, is not the only one viable. Another way of accounting for the pattern is to recognize the phonetic similarity between phrase-final syllables and syllables in shorter words — they are both longer in duration than their respective counterparts — and relate the durational advantage to the greater contour tone licensing ability. Both final lengthening (e.g., Oller 1973, Klatt 1975, Wightman et al. 1992) and lengthening of syllables in shorter words (e.g., Lehiste 1972, Lindblom, Lyberg, & Holmgren 1981, Lyberg 1977) have been well-established in the literature; and contour tones, which involve articulator movements in its production and decoding of pitch change perceptually, demand sufficient duration in their realization. Thus, the contour licensing privilege of these types of syllables may not be the artifact of tonal melody mapping, but stem from the durational characteristics of these syllables and the functional need for contour tones to be realized safely.

The aim of this paper is to put these two analyses to test, and eventually argue for the latter. The first argument is on the generality of the approach. Together with Zoll (2003), I show that the concept of tonal melody is unworkable for many languages, including some that have been traditionally considered as exemplars of tonal melodies. Next I show that even for languages in which tonal melodies can be validated, the analysis cannot be properly rendered in Optimality Theory (Prince & Smolensky 1993) without specifically identifying the prosodic-final syllables and syllables in shorter words as privileged contour tone licensors. Third, I discuss languages that purportedly have right-to-left melody mapping and show that there is in fact no tendency for contour tones to surface on the initial syllable of the prosodic domain. The initial vs. final asymmetry must then lie in the difference between the initial and final syllables, not the direction of the melody mapping. And finally, I further support the durational approach by refuting another alternative advanced by Hyman (2004a, b) — i.e., it is not the tone on the final syllable, but the final tone in a tonal sequence, that receives contour licensing advantage — on the grounds that the ‘final tone’ approach leaves the door open for a comparable ‘initial tone’ approach and also loses a generalization that unifies the gravitation of contour tones not only to prosodic-final syllable and syllables in shorter words, but also long-voweled and stressed syllables (Duanmu 1990, 1994a, b, Yip 1989, 1995, Zhang 2002).

2. To map or not to map

2.1 The lack of universal validity of tonal melodies

If tonal melody mapping is to be taken as a general account for the primacy of syllables in prosodic-final position and in shorter words in contour tone licensing, it must be shown to be a valid notion cross-linguistically, not just in African languages where most of its motivations come from, as the licensing asymmetries are manifested in languages with diverse genetic affiliations. But in some Sino-Tibetan, Daic, Oto-Manguean, and Trans-New Guinea languages, the notion of tonal melody over a larger prosodic domain is possibly irrelevant, at least on the lexical level. Let me illustrate this point with examples.

2.1.1 Beijing and other Northern Chinese dialects

Beijing Chinese, along with virtually all other Northern Chinese dialects, have lexical contour tones. The four tones in Beijing Chinese are illustrated in (5).²

² Tones are marked with Chao letters (Chao 1948, 1968). ‘5’ and ‘1’ indicate the highest and lowest pitches in a speaker’s regular pitch range. Combinations of numbers indicate contour tones. For example, 53 indicates a high-falling tone; 13 indicates a low-rising tone.

- (5) Lexical tones in Beijing Chinese:
- | | |
|--------|------------|
| ma 55 | ‘mother’ |
| ma 35 | ‘hemp’ |
| ma 213 | ‘horse’ |
| ma 51 | ‘to curse’ |

Moreover, the tone sandhi patterns in these northern dialects do not involve spreading as in Shanghai. Instead, they have been referred to in the literature as ‘pattern substitution’ (Chan & Ren 1986) or ‘syllable-bound’ (Bao 2004); i.e., a tone on a syllable paradigmatically changes into another tone when combined with other tones. The sandhi pattern in Beijing is illustrated in (6). We can see that the tone 213 paradigmatically changes into 21 or 35 in nonfinal position. The changed tones are not the result of spreading from adjacent tones.

- (6) Beijing tone sandhi:
- | | |
|----------------------------------|----------------------------------|
| a. 213 in final position: | b. 213 in nonfinal position: |
| 55- 213 → 55- 213 | 213 -55 → 21 -55 |
| 35- 213 → 35- 213 | 213 -35 → 21 -35 |
| 213- 213 → 35- 213 | 213 -213 → 35 -213 |
| 51- 213 → 51- 213 | 213 -51 → 21 -51 |

But let us note that although Beijing tone sandhi does not result from tonal melody mapping, it exhibits the same licensing asymmetry for contour tones as in Kikuyu — more complex tones occur more freely in final position. In fact, this observation has spawned a number of analyses that treat the sandhi tones 21 and 35 as simplifications of the base tone 213 (e.g., Yin 2002). If we take melody mapping as the account for such final advantage in Kikuyu, we must look for the account for Beijing elsewhere. This is an undesirable dichotomy.

2.1.2 Ron Phibun Thai

Ron Phibun Thai (henceforth RP Thai) is a southern Thai language in the Daic language family. Its tone sandhi behavior is documented and analyzed by Thompson (1998). There are seven citation tones on ‘unstopped’ syllables (CVV, CVR, and CVVR; R=sonorant) in RP Thai, as illustrated in Figure 1. Tone 1 and Tone 3 are convex tones, Tone 2 and Tone 4 are level, Tone 5 and Tone 7 are falling, and Tone 6 is rising.

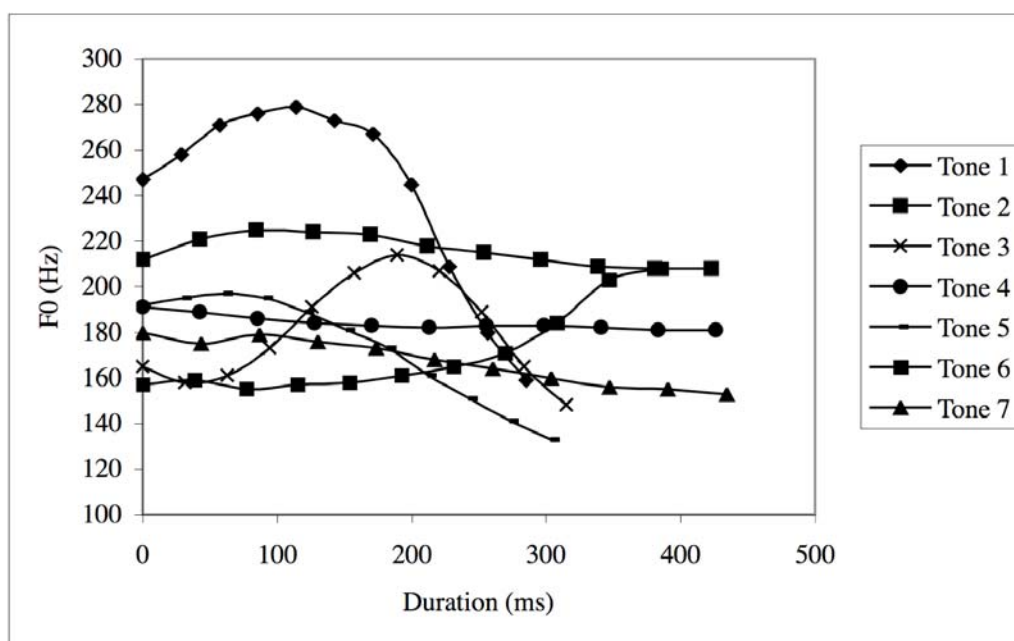


Figure 1: Ron Phibun Thai citation tones in unstopped syllables (adapted from Thompson 1998)

But when an unstopped syllable occurs in the initial position of a disyllabic word, a number of tone sandhi processes are triggered. Most notably, the two convex tones (Tones 1 and 3) lose the initial rise portion and become falling tones, and consequently Tone 5, which is also falling, is neutralized with Tone 3. This can be observed in Figure 2.

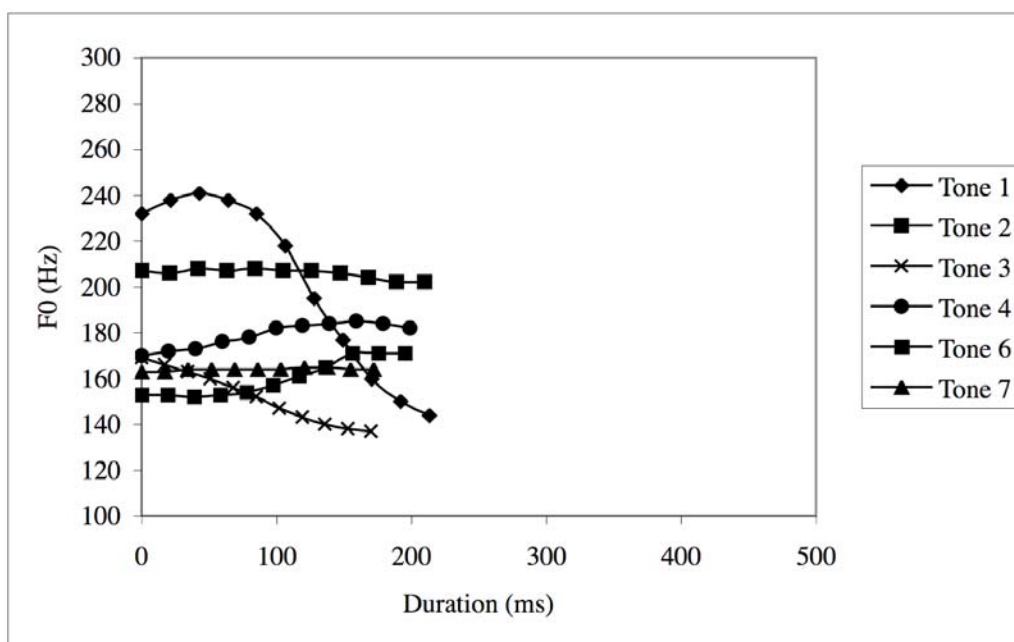


Figure 2: Ron Phibun Thai tones in syllable 1 of disyllabic utterances (adapted from Thompson 1998)

This is clearly another case in which the licensing of more complex tones in final position does not result from the spreading of a tonal melody across the word according to the Association Conventions. Thompson (1998) analyzes the tonal changes as truncation from the left edge. But whatever formalism the analysis assumes, the intuition is clear: convex tones are simplified to simple contours in nonfinal position due to the lack of sufficient durational support. The durational difference between the citation tones and tones on the first syllables of disyllabic utterances is apparent in the comparison between Figures 1 and 2.³

Support for the durationally driven analysis also comes from the behavior of tones on ‘stopped’ syllables (CVO, CVVO; O=obstruents). On such syllables, the tonal inventory is much reduced. Only Tones 1, 3, and 5 can occur on CVO and only Tones 2, 4, and 6 can occur on CVVO. What is of particular interest to us is the phonetic realization of Tones 1, 3, and 5 on CVO. RP Thai, like many other Sino-Tibetan and Daic languages, shortens the vowel duration tremendously before an obstruent coda. Consequently, the tonal contours of Tones 1, 3, and 5 are all simplified (Tones 1 and 3 from convex to rise, and Tone 5 from fall to level). Both the durational and pitch properties of these tones are shown in Figure 3.

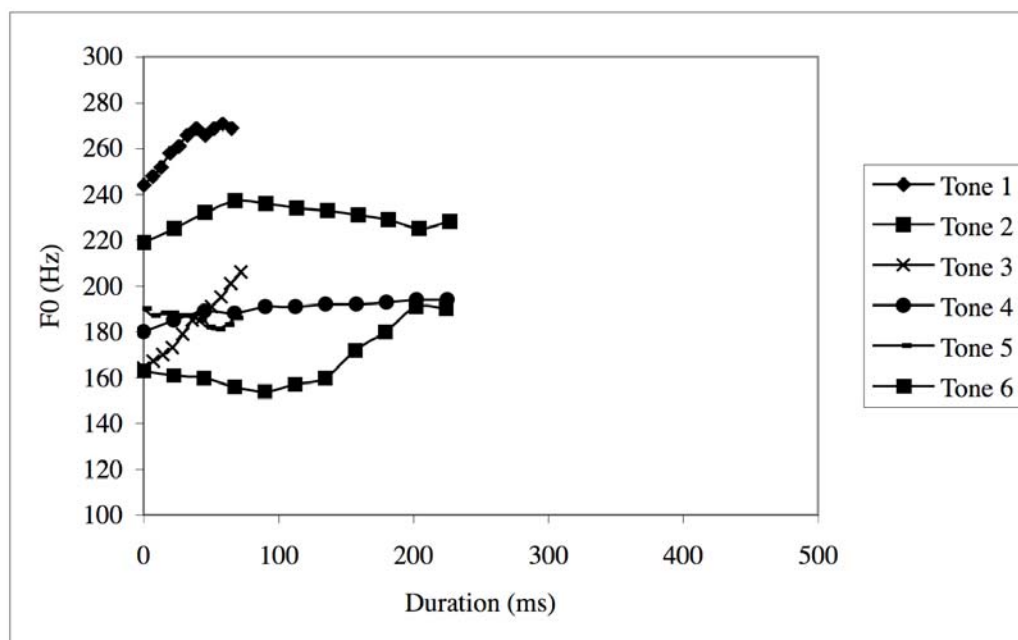


Figure 3: Ron Phibun Thai citation tones in stopped syllables. Only Tones 1, 3, and 5 occur on CVO and only Tones 2, 4, and 6 occur on CVVO (adapted from Thompson 1998)

³ One might argue that for both Beijing and RP Thai, the relevance of tonal melodies is reflected on the moraic level, as in both languages, the simplification of contour tones in nonfinal position can be seen as leaving off pitch targets that do not have enough moras to map onto. But this is fundamentally different from the melody-mapping account of final privilege and quite in line with the durationally driven theory advanced here, in that the durational advantage of the final syllable must be taken into consideration, specifically, in the form of extra moras.

Intuitively, the simplification here happens for exactly the same reason as in nonfinal position — the duration of the tone carrier is insufficient to support a more complicated tonal contour. Tonal melody mapping again does not directly bear on the pattern here and thus as a theory misses apparent correlations between empirical observations. As for the reduction of tonal inventory on ‘stopped’ syllables, although the durational approach does not predict exactly which tones will survive in the inventory, the reduction of the inventory itself is surely durationally governed, just as the reduction of vowel inventory in unstressed syllables in English and Russian (Crosswhite 2001, 2004).

2.1.3 Trique

Hollenbach (1977) provides detailed phonological descriptions of two Trique dialects spoken in Oaxaca, Mexico — San Juan Copala (hereafter SJC) and San Andrés Chicahuaxtla (hereafter SAC), both of which are tonal.

SJC has five long vowels /i, e, a, o, u/ and three short vowels /e̞, o̞, a̞/, all of which may be nasalized. Hollenbach describes the short vowels /e̞, o̞/ as having a more open articulation than their long counterparts. Long vowels occur in both ultimas and non-ultimas, while short vowels only occur in unchecked ultimas. Nasalization is contrastive for ultima vowels only and extends regressively to non-ultimas until a consonant barrier (any consonant other than /j, w, ʔ/) is reached. All syllables are open, except that the ultimas may be checked by a final /ʔ/ or /h/. A long vowel is extra long in an unchecked ultima, but in a checked ultima or non-ultima, it is fairly short. Except in Spanish loans, long /e/ and /o/ mainly occur in non-ultimas when the ultima vowel is also mid. In addition, non-ultimas ‘are articulated so rapidly that the vowel is often reduced and/or devoiced’ (p.42).

Hollenbach’s description prompts the following generalizations on vowel duration in SJC: final unchecked long vowels have the longest duration, followed by final short vowels and checked long vowels; nonfinal long vowels, albeit phonologically [+long], have the shortest duration, as indicated by their tendency to reduce and devoice as well as their inability to carry [±nasal] and [±high] contrasts.

SJC has eight tones — three level /3, 2, 1/, two falling /32, 31/ and three rising /45, 34, 13/⁴. In unchecked ultimas with a long vowel, all eight tones occur, as exemplified by the minimal eight-tuplet in (7).

⁴ To be consistent with the rest of the paper, I use Chao letters to represent tones in SJC; i.e., 1 represents low and 5 represents high. Hollenbach uses the Americanist transcription in which 1 represents high and 5 represents low. Therefore, the eight tones in Hollenbach’s notation are 3, 4, 5, 34, 35, 21, 32, and 53.

(7)	jã3	‘he is sitting’	jã31	‘scar’
	jã2	‘unmarried’	jã45	‘to be sitting’
	jã1	‘one’	jã34	‘corncob’
	jã32	‘salt’	jã13	‘Spanish moss’

On unchecked ultimas with a short vowel, all but 45 and 31 occur, as shown in (8).

(8)	guno3	‘to hear (completive)’	guno32	‘to sow (completive)’
	guno2	‘to sow (potential)’	ganõ34	‘to grab (completive)’
	ganõ1	‘to grab (potential)’	gunõ13	‘to hear (potential)’

On ultimas checked by /h/, all but 34 occur, but 31 is very rare (9).

(9)	jaʔah3	‘chili pepper’	majah31	‘yellow’
	nuh2	‘generous’	jaʔah45	‘gourd’
	ni3nuh1	‘bean gruel’	ga3nuh13	‘shoe’
	jaʔãh32	‘god’		

On ultimas checked by /ʔ/, all but 32 occur, but 45 and 31 are very rare, and 34 only occurs as a sandhi tone (10).

(10)	nãʔ3	‘to start from home’
	rune32 nanaʔ2	‘large black beans’
	mãʔ1	‘two (tortillas)’
	zagaʔ13	‘spleen’
	ʔsaʔ31 (variant of a3zaʔ5)	‘how? (with a component of surprise)’
	ʔsĩʔ45 (variant of ʔsĩʔ3)	‘tiny’
	nãʔ34 zoʔ1	‘you start from home’
		(cf. nãʔ3 ‘to start from home’)

And finally, only 3, 2, and 45 occur on non-ultimas, as in (11).

(11)	gwe3se1	‘judge’
	ga2jã45	‘to sit’
	ja45nuh13	‘drum’

The tonal restrictions in SJC Trique match the durational pattern of the language quite well. The largest number of tonal contrasts is realized on the position that has the longest duration, namely, final unchecked long vowels. A slightly reduced inventory is attested on final checked long vowels and final short vowels, which have shorter duration. Nonfinal long vowels, which are the shortest in duration, can only support a vastly reduced tonal inventory. The effect of final position is apparent: it outweighs the durational disadvantage of [-long] and causes final short vowels to have a longer duration than nonfinal long vowels, and the extra duration enables the former to have a greater tonal inventory than the latter.

Although SAC Trique receives a different tonal analysis from SJC in Hollenbach (1977) in that it is considered to be a ‘register’ rather than a ‘contour’ system, we can make similar generalizations on its tonal inventory: with no vowel length contrast, unchecked ultimas have a full inventory with contour tones, checked ultimas have a reduced inventory with contour tones, and non-ultimas can only have level tones.

The fact that the ultimas in SJC and SAC Trique are better contour tone carriers clearly cannot be due to tonal melody mapping. Although the durational properties of final and nonfinal syllables do not directly predict which tones will survive in the inventory, the reduction of the inventory itself is surely durationally governed. This again finds parallel in vowel reduction in unstressed syllables in languages like English and Russian (Crosswhite 2001, 2004). Although Crosswhite’s analyses are mostly concerned with cases of alternation, they may be extended to predict inventories for vowels and tones alike.

2.1.4 Mianmin

Mianmin belongs to the Ok family of the Trans-New Guinea language phylum. The variety of which we have detailed phonological documentation (by Smith & Weston 1974) is spoken in the West Sepik District of Papua New Guinea.

Mianmin has five vowels /i, e, a, o, u/ and four diphthongs /eⁱ, aⁱ, a^u, o^u/. Its syllables are either open or closed by one consonant, which can be an obstruent or a nasal. There are ‘lengthened vowels’ according to Smith & Weston (1974), which are ‘from 1 1/2 to 2 times the length of a single vowel.’ (p.14) But they are interpreted ‘as a sequence of two vowels and are two syllable nuclei.’ (p.14)

There are four contrastive tones in Mianmin — high (ˊ), low (ˋ), high falling (ˊˋ), and low rising (ˊˋ). On monosyllabic words, all tones are attested, as show in (12).^{5,6}

(12) Mianmin tones on monosyllabic words:

H:	[k ^h ɪn]	‘eye’	[gát ^h]	‘mole’	[t ^h á ⁱ]	‘axe’
L:	[k ^h ɪn]	‘insect sp.’	[às]	‘tree’	[sà ⁱ]	‘vine’
HL:	[fâp]	‘where’	[krâ]	‘properly’	[â]/[tâ]	‘and’
LH:	[dǔm]	‘point of taro’				

On disyllabic words, the following tone patterns occur:

⁵ Smith & Weston (1974)’s transcriptions have been adapted to IPA.

⁶ Although Smith & Weston (1974) state that the high falling tone does not occur on monosyllabic words (p.29), there are three words in their data that go against this generalization: [fâp] ‘where’, [krâ] ‘properly’, and [â]/[tâ] ‘and’. I thus assume that the generalization is not true.

(13) Mianmin tones on disyllabic words:

L-L:	[k ^h è̀mìt]	‘gourd’	[bèsà]	‘nothing’	[ùkt ^h è̀m]	‘ash’
L-H:	[k ^h àwá]	‘axe’	[bìmán]	‘snake’	[wà’sá]	‘cut’
L-LH:	[màngǝk]	‘bee’	[àmǔn]	‘stomach’	[k ^h òmǝk]	‘headman’
L-HL:	[àtdâ]	‘cliff’	[dàmîp]	‘garden’	[bàsî]	‘nose tusk’
H-H:	[múnúŋ]	‘nose’	[búbúr]	‘flower’	[t ^h émbár]	‘young man’
H-L:	[ánòk]	‘bow’	[ájàp]	‘uncle’	[jábìr]	‘down place’
H-HL:	[k ^h wé ^l ôn]	‘hand’	[bábâr]	‘veranda’	[búk ^h ûm]	‘charcoal’

On trisyllabic words, the following tone patterns occur:

(14) Mianmin tones on trisyllabic words:⁷

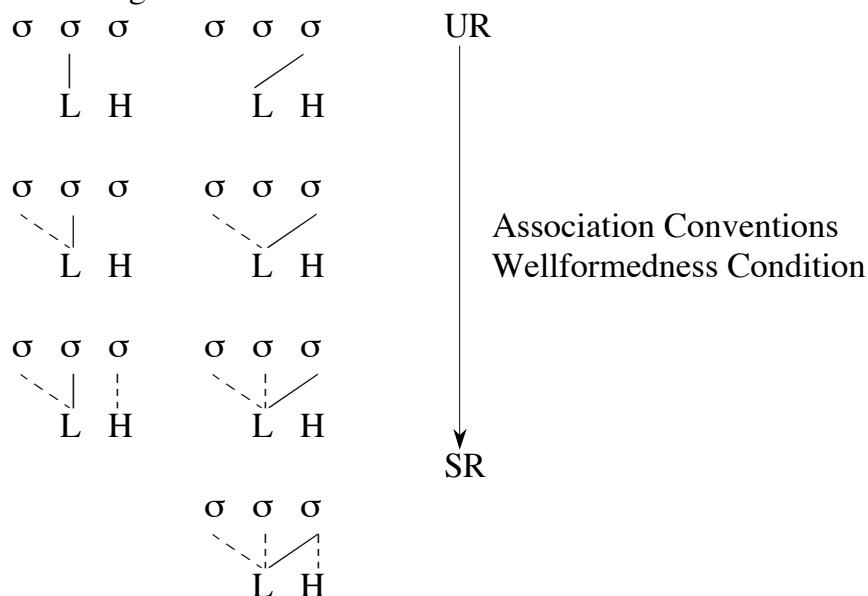
L-L-L:	[fànìwàr]	‘ancestors’	[t ^h ùnùmìn]	‘wasp’s nest’
L-L-H:	[k ^h àt ^h àbám]	‘cave’	[àfùnán]	‘leg hair’
L-L-LH:	[àk ^h ùrǎp]	‘aunt’	[àt ^h òt ^h ǝp]	‘spark’
L-L-HL:	[wèsèmê]	‘canoe’	[gèt ^h àt ^h ôn]	‘skull’s hollow’
L-H-L:	[bèmámìn]	‘caterpillar’	[t ^h írúsàm]	‘roofing grass’
L-H-H:	[ùk ^h árí]	‘pumpkin’	[màápsé ⁱ]	‘tortoise sp.’
H-H-L:	[bánákrà]	‘underneath’	[ík ^h ámwàr]	‘married couple’
H-H-H:	[síníbí]	‘crocodile’	[úmásó ^u]	‘eel’
L-H-HL:	[bàánôn]	‘jaw’		
H-L-H:	[fát ⁿ àmín]	‘what, when’		
H-H-HL:	[búkúpsân]	‘beads’		

From the data above, we can clearly see that the contour tones are strictly restricted to word-final syllables, while the high and low tones are generally free in their distribution. Certain melodies do seem to be missing from di- and trisyllabic words even with the contour restrictions taken into account, e.g., H-LH in disyllables, and H-L-L, H-L-LH, H-L-HL, H-H-LH, and L-H-LH in trisyllables. This may seem to be an argument for a melody mapping analysis. But three facts suggest that such an analysis is inappropriate. First, the motivation for tonal melodies is often the economy of the analysis, in that a very limited number of melodies can account for all the data. But in Mianmin, the melodies that are needed far exceed the ones that are missing. Second, disyllables and trisyllables do not instantiate the same melodies. E.g., H-L-H is attested on trisyllables, but H-LH is missing on disyllables; H-L is attested on disyllables, but H-L-L is missing on trisyllables. Third, there are melodies that do not observe the one-to-one, left-to-right Association Conventions, and the association is contrastive; e.g., the LH melody has contrastive realizations L-H and L-LH on disyllables and L-H-H, L-L-H, and L-L-LH on trisyllables. There are two possible ways to resolve this conundrum without violating the Association Conventions. One is to posit different tonal melodies for the different associations, e.g., L-H-H, L-L-H, and L-L-LH are of the melodies LHH, LLH, and LLLH respectively. This further vitiates

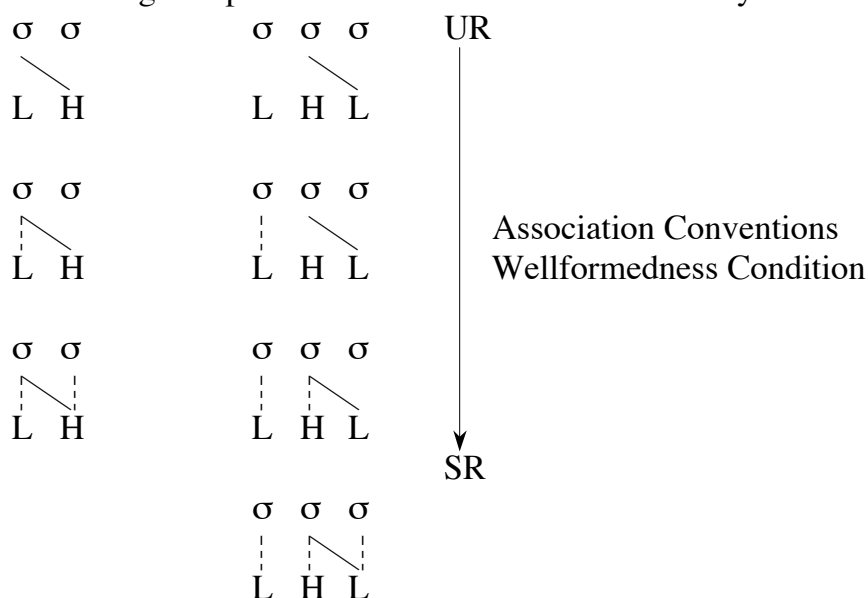
⁷ Smith & Weston (1974) do not list L-H-HL, H-L-H, and H-H-HL in their discussion of tonal distribution. But these patterns show up in examples they give elsewhere in the paper.

the economy advantage of melody mapping. The other is to posit prelinking in the underlying representation. E.g., L-L-H and L-L-LH have the underlying forms as shown in (15a). Then the Association Conventions and Wellformedness Conditions predict the correct surface forms (see Leben 1978, who adopted this solution for a similar problem in Mende). But this analysis renders the restriction of contour tones to word-final syllable completely accidental, as one can easily imagine prelinking scenarios that produce contour tones on nonfinal syllables, for example, the one in (15b). Therefore, it eliminates any explanations for the gravitation of contour tones to word-final syllable under melody mapping.

(15) a. Prelinking that resolves contrastive association:



b. Prelinking that produces contour tones on nonfinal syllables:



2.1.5 Local conclusion

In the previous sections, we have seen four languages from four different language phyla that have a final advantage in contour tone bearing. In none of these languages can the final advantage be appropriately derived from one-to-one, left-to-right melody mapping. But there is a clear correlation between the duration of the final syllable and its attraction of contour tones. The durational property is explicitly discussed in three of the four languages, and given the prevalence of final lengthening, it would not be surprising that Mianmin has a similar durational profile. This constitutes one reason that even in languages in which tonal melodies can be shown to be relevant, the mapping mechanism is not the explanation for the final advantage for contour tone bearing, as otherwise we would need two separate accounts for the phenomenon when there is a unifying factor that can do the job. In §4, I also show that the mapping derivation alone cannot be translated into the OT framework to account for the gravitation of contour tones to final syllables and syllables in shorter words, and the durational advantage of these syllables must be acknowledged in the analysis.

2.2 Exemplars of tonal melody mapping revisited

The last section identifies languages for which tonal melody is not a relevant concept. This section looks in more detail at languages in which tonal melodies are purportedly responsible for the distributional asymmetries of contour tones and argues that none of the celebrated cases of melody mapping holds up under closer scrutiny. The bulk of the arguments in this section stems from Zhang (2000a) and Zoll (2003), which are acknowledged at appropriate places.

2.2.1 Mende

First discussed in the generative framework by Leben (1971, 1973, 1978), Mende is arguably the most celebrated case of tonal melodies. Leben claims that there are five basic melodic patterns in Mende: H, L, HL, LH and LHL. These patterns are mapped onto syllables in the word one-to-one, left-to-right. The examples in (16) illustrate these melodic patterns in words up to three syllables (from Leben 1978):

(16) Mende examples:

	σ	$\sigma\sigma$	$\sigma\sigma\sigma$
H	kó ‘war’	pélé ‘house’	háwámá ‘waistline’
L	kpà ‘debt’	bèlè ‘trousers’	kpàkàñ ‘tripod chair’
HL	mbû ‘owl’	ngílà ‘dog’	félàmà ‘junction’
LH	mbă ‘rice’	fàndé ‘cotton’	ndàvúlá ‘sling’
LHL	mbẵ ‘companion’	nyàhâ ‘woman’	nìkíñ ‘groundnut’

Dwyer (1971, 1978, 1985), however, challenges Leben’s melody mapping view. He claims that tones are associated with syllables underlyingly in Mende.

His major contentions are two. First, the five tonal patterns Leben provides do not account for all of the Mende lexicon. Other patterns, such as HLH and HLHL, are also attested, illustrated by examples in (17). Second, the mapping analysis cannot formally capture the following contrasts: H-L and H-HL in disyllables; H-L-L and H-H-L, L-H-H and L-L-H in trisyllables. But these contrasts exist in Mende, as shown (18).

- (17) a. HLH: yámbùwú ‘tree (sp)’
 lánsàná ‘proper name’
 lénàá ‘for now’
 b. HLHL: náfàlê ‘raphia clothed clown’
 njéngùlû ‘tarantula’
 dúmbèékà ‘star’
- (18) a. H-L: káñ ‘hoe’ ngílà ‘dog’
 H-HL: kónyô ‘friend’ hókpô ‘navel’
 b. H-L-L: fèlàrà ‘junction’ mólímò ‘Muslim’
 H-H-L: símbíû ‘spider’ kókóñ ‘seek’
 c. L-H-H: ndèndéí ‘shade’ ndàvúlá ‘sling’
 L-L-H: kòlòbé ‘none’ lèlémá ‘praying mantis’

Rather than treating the contrasts in (18) as the result of partial prelinking (Leben 1978), Dwyer contends that all tones in Mende must be prelinked to the TBUs in the underlying representation rather than associated to TBUs by the Association Conventions during the course of the derivation. He hence refers to the approach as a ‘segmental’ approach.

The major criticism held against Dwyer’s analysis is that it overgenerates tonal patterns that are not attested. For example, Conteh et al. (1983) list the following patterns in trisyllabic words that are predicted by the prelinking analysis, but not attested in Mende:

- (19) a. CVCVCV b. CVCVCV c. CVCVCV d. CVCVCV
 $\begin{array}{c} \nearrow \quad | \quad | \\ \text{HL} \quad \text{H} \quad \text{H} \end{array}$ $\begin{array}{c} \nearrow \quad | \quad \searrow \\ \text{HL} \quad \text{H} \quad \text{HL} \end{array}$ $\begin{array}{c} \nearrow \quad \nearrow \quad \searrow \\ \text{HL} \quad \text{HL} \quad \text{HL} \end{array}$ $\begin{array}{c} | \quad \searrow \quad \searrow \\ \text{H} \quad \text{HL} \quad \text{HL} \end{array}$
- e. CVCVCV f. CVCVCV g. CVCVCV
 $\begin{array}{c} | \quad \searrow \quad \searrow \\ \text{L} \quad \text{HL} \quad \text{HL} \end{array}$ $\begin{array}{c} \nearrow \quad | \quad | \\ \text{HL} \quad \text{H} \quad \text{L} \end{array}$ $\begin{array}{c} \nearrow \quad \nearrow \quad | \\ \text{HL} \quad \text{HL} \quad \text{H} \end{array}$

However, it is apparent that all patterns in (19) involve the HL contour on nonfinal syllables. Therefore, these missing patterns do not instantiate overgeneration of Dwyer’s segmental approach; instead, they illustrate that Mende, like many other languages, displays a common pattern of contour tone distribution — the preference for final syllables. Aided by the reference to final syllables as privileged contour carriers, Dwyer’s analysis better captures the tonal

patterns of Mende by doing away with tonal melodies, and at the same time does not necessarily overgenerate any of the patterns in (19).

One complication in Mende is that contour tones on nonfinal syllables are in fact attested — Dwyer (1978) lists a number of words with a HL or LH contour on nonfinal syllables. But these syllables invariably have a long vowel, as in (20).

(20)	LH-H:	bèésí	‘pig’
	LH-L:	nyàápò	‘mistress’
	HL-L:	wóòmà	‘back’

Leafing through Innes’s ‘Mende-English Dictionary’ (1969), not only do we find numerous examples of this sort, we also find long vowels with level tones, e.g., *sòò* ‘long’ and *néé* ‘boil’. Therefore vowel length does seem to be contrastive in Mende, even though Leben is not willing to commit to such a view. Dwyer also argues that the monosyllabic word for ‘companion’ in (16), which carries a LHL contour, should be transcribed with a long vowel — *mbàâ*. This argument finds support in Spears (1967) and Innes (1969), both transcribing the word with a long vowel.

The final complication in Mende is on the surface realization of its rising tone LH. On a long vowel, a rising tone can surface as such, as illustrated by words like *bèésí* ‘pig’ in (20). But on a short vowel, the rising tone usually behaves as a ‘polarized tone’: it surfaces as a downstepped H before a pause or L, and as a L before a H, which is subsequently downstepped. This is illustrated by the data in (21) (Dwyer 1978:182).

(21)	UR:	njǎ	
	SR before #:	nj [!] á	‘water’
	SR before L:	nj [!] á-fèlé	‘two rivers’
	SR before H:	njè- [!] í	‘the water’

If the above generalizations about the rising tone are true without exceptions, we are inevitably led to the conclusion that the rising tone LH can only occur on long vowels. But Leben (1973:187) claims that the words for ‘rice’ (*mbǎ*) and ‘kill’ (*pǎ*) do have a rising pitch. He further asserts that the simplification of the rising tone does not apply to monosyllabic nouns and verbs. This statement is obviously in disagreement with the data in (21), which show rising simplification on a monosyllabic noun. Therefore it is plausible that the downstepped High, or rather, Mid, is a contrastive tone in Mende. But with the scarcity of data, no definitive statement can be made regarding this. The relevant point here, however, is the following: if a rising pitch WERE TO occur on a short vowel, it could only occur on monosyllabic nouns or verbs. This statement does not contradict either of the data sources — Leben (1973) and Dwyer (1978).

We are thus led to the following generalizations regarding the distribution of contour tones in Mende. Long vowels can carry a complex contour LHL in monosyllabic words; they can carry a simple contour HL or LH in other positions. Short vowels can carry either of the simple contours HL and LH in monosyllabic words; they can carry the falling contour HL in the final position of di- or polysyllabic words; they cannot carry contours in other positions. These generalizations are summarized in (22).

(22) Mende contour tone restrictions:

Vowel length	No. of syllables in word	Syllable position in word	LHL ok?	LH ok?	HL ok?
VV	1	final	yes	yes	yes
VV	>1	any	no	yes	yes
V	1	final	no	yes	yes
V	>1	final	no	no	yes
V	>1	nonfinal	no	no	no

We can see that the contour limitations in Mende are largely due to durational factors instead of restrictions on tonal melodies. For instance, the restriction of LHL to long vowels in monosyllabic words finds explanation in the complexity of the tone and the fact that this vowel, being [+long], final, and in monosyllabic words, is durationally triply advantaged. Tonal melodies alone cannot explain this restriction: the melody HLHL, which would give rise to LHL on the final syllable of a disyllabic word if mapped one-to-one, left-to-right, is attested, e.g., *náfâlê* ‘raphia clothed clown’ (see (17)).

At this point, we can clearly see that the limited inventory of tonal melodies and their mapping to segmental contents as envisioned by Leben do not provide an adequate account for Mende tones. But Mende nonetheless displays the preferences for contour tones to appear on prosodic-final syllables and syllables in shorter words. As suggested earlier, the real account lies in the phonetic peculiarity of these syllable types, namely, they are longer in duration than *ceteris paribus* syllables in other positions.

2.2.2 Etung

Etung is a Bantu language with three basic tones — High (H), Low (L), and Downstep (↓H) (Edmondson & Bendor-Samuel 1966). Syllables in Etung can be CV, CVO or CVR. No vowel length contrast is documented. Edmondson and Bendor-Samuel observe that while there is no restriction on the occurrence of level tones, the falling and rising contours (HL, H↓H, LH) are restricted to the final syllable of mono- and disyllabic phonological words. They account for this effect by taking tone as a feature of the phonological word. They identify 12 patterns of

tonal melody composed of the three level tones and map them from left to right to syllables in a phonological word. These patterns are shown in (23).

(23) Patterns	$\sigma \sigma \sigma$	$\sigma \sigma$	σ
1	L-L-L	L-L	L
2a	L-H-H	L-H	LH
2b	!H-H-H	!H-H	!H
3	H-L-L	H-L	HL
4	H-H-H	H-H	H
5	L-H-L	L-HL	—
6	L-L-H	L-LH	—
7	H-H-L	H-HL	—
8	H-!H-H-	H-!H	H!H
9	H-L-H	H-LH	—
10	L-H-!H	L-H!H	—
11	H-H-!H-	H-H!H	—

Goldsmith (1976) subsequently proposes to simplify melodies 1, 2a, 3, and 4 to L, LH, HL, and H. But Zoll (2003) observes that these melodies and the conventional mapping mechanism do not account for patterns such as L-L-H and H-H-L on trisyllables and consequently questions the melody mapping approach. Furthermore, as Morris Halle has pointed out (Goldsmith 1976:156, footnote 2), the eight patterns that do not involve !H include all the melodies expressible as $T_1T_2T_3$. This observation makes the melodic approach immediately less attractive, as it does not serve the purpose of restricting possible tonal combinations in polysyllabic word. The missing patterns can be described by the common restrictions on contour tone distribution alone: (a) contour tones only occur on word final syllables; (b) contour tones cannot occur in words with more than three syllables; (c) complex contours with three or more pitch targets do not occur. These restrictions are related to the durational advantage of syllables in prosodic-final position and words with fewer syllables. This position is also endorsed by Zoll (2003).

2.2.3 Kukuya

The tonal pattern of Kukuya is very similar to that of Mende envisioned by Leben (Paulian 1974, Hyman 1987). Paulian (1974) argues that there are also five tonal melodies in Kukuya: H, L, HL, LH, and LHL, and they are mapped one-to-one, left-to-right to syllables in the word. Examples in (24) show the mapping of tones in words with up to three syllables. A significant glitch to the mapping analysis is in the word for ‘younger brother,’ which is in bold in the table in (24) — it has a L-L-H pattern instead of the expected L-H-H, as if tones are mapped from right to left in this particular case.

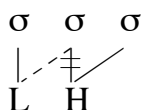
(24) Kukuya examples:

	σ	$\sigma \sigma$	$\sigma \sigma \sigma$
H	bá 'oil palms'	bágá 'show knives'	bálágá 'fence'
L	bà 'grasshopper killer'	bàlà 'to build'	bàlàgà 'to change route'
HL	kâ 'to pick'	kálà 'paralytic'	kálàgà 'to be entangled'
LH	sǎ 'weaving knot'	sámí 'conversation'	m^wàrəǵí 'younger brother'
LHL	bṽĩ 'he falls'	pàfi 'he goes out'	kàlǵgì 'he turns around'

Paulian (1974) suggests that the tonal melodies are associated with the moras in an 'edge-in' (Yip 1988) fashion in trimoraic words, as the first and the last moras receive primary and secondary accents respectively. The unaccented middle mora, which corresponds to the 'prosodic trough' in Hyman (1998)'s term, receives the default L, giving rise to H-L-L in the case of the HL melody and L-L-H in the case of LH.

In keeping with the left-to-right mapping convention, Hyman (1987) proposes a special 'fix-up' rule that spreads a L one syllable to the right if the following syllable is associated with a doubly linked H, and subsequently delinks the first H association, as in (25).

(25) Kukuya 'fix up' rule (Hyman 1987):



Zoll (2003) argues that the exceptional case here in fact reflects a cross-linguistic principle which she terms CLASH — there is no H sequence on adjacent TBUs. Therefore the tone mapping in Kukuya does not proceed from left to right, but ensures the satisfaction of the highly ranked CLASH constraint. This constitutes one part of her framework on tone mapping that does away with directionality in the traditional Association Conventions.

Thus, Kukuya illustrates a slightly different point from Mende and Etung. For the latter two languages, tonal melodies lack principled motivation: in order to derive all the lexical patterns, the number of melodies that have to be postulated approaches the number of possible tonal combinations given the tonal inventory. For Kukuya, however, the motivation for tonal melodies is considerably stronger, as unlike Mende, no examples have been put forth to contradict the existing five melodies. What is being challenged is the directionality of the mapping convention *per se*. But as we have seen, the directionality is the crucial mechanism that

restricts contour tones to domain final syllables. Thus, if it cannot be established, the privilege of domain final syllables has to find its explanation elsewhere. And clearly, Kukuya does exhibit the familiar effects: contour HL can only occur on monosyllabic words or the final syllable of disyllabic words.

2.3 Languages in which tonal melodies are motivated

2.3.1 Banned tonal melodies

The Kukuya case that we have seen indicates that the notion of tonal melody does have its merit on the lexical level, since Kukuya truly has a limit on the number of tonal combinations that can occur in a word. Granted that we do not find patterns like HLH, HLHL associated with words, we must consider constraints like *HLH-WORD, *HLHL-WORD to be relevant for Kukuya, and in this we find the justification for lexical tonal melodies. But these melodies are quite different from those envisioned in mapping analyses, where a melody is a contrastive phonological entity. The banned melodies simply represent phonotactic restrictions on tonal sequencing.

2.3.2 Morphological melodies

Tonal melody can also be a useful notion morphologically. For instance, in Tiv, each verb tense is marked with one of two tonal melodies — a High melody or a Low melody (Abraham 1940, Arnott 1964, McCawley 1970, Goldsmith 1976). The two melodies for the general past tense on one, two, or three syllable words are given in (26).

(26) Tiv general past tense:

	σ	$\sigma\sigma$	$\sigma\sigma\sigma$
High melody !HL:	!H	!HL	!HLL
Low melody L:	L	LL	LLL

From the behavior of the High melody on trisyllabic words, we know that the mapping here proceeds from left to right. Zoll (2003) terms the directionality of melody mapping required by grammatical morphemes ‘morphological directionality.’ She argues that this is the only type of directionality that is attested in tonal melody mapping; phonological directionality, which maps tones to segmental contents in underived environments, cannot be empirically established. Morphological directionality can be either left-to-right, as in Tiv general past tense, or right-to-left, as in Hausa plural nouns (Newman 1986, 2000) and Kanakuru verb stems (Newman 1974). To render this in OT, we need alignment constraints in the form of ALIGN(Cat1, Edge1, Cat2, Edge2), where Cat1 belongs to a grammatical category, and Cat2 belongs to a prosodic category (McCarthy & Prince 1993). The Edge parameters can be either Left or Right. Left-alignment represents a prefixing melody, while Right-alignment represents a suffixing melody.

In traditional terms, morphological melodies do not seem to observe the left-to-right convention of lexical melodies. This is due to the choice of prefixation or suffixation available to morphology. Tonal infixation is also attested. Zoll (2003) argues that the recent past tense marker in Tiv is a High tone infixed onto the second syllable of the verb stem, and her analysis of such tonal infixation is similar to that of segmental infixation: it is the imperfect realization of a prefix (or suffix) due to some highly ranked constraint; in this case, a positional faithfulness constraint protecting the underlying tone on the initial syllable.

In terms of contour tones, morphological melodies predict that they should occur word-finally if the association is left-to-right, and word-initially if the association is right-to-left. As I show later in §4, in an OT rendition of the former scenario, we need constraints specifically banning contour tones on nonfinal syllables as well as ALIGN-L constraints. The latter scenario, however, is not attested: although there are cases of suffixing melody, they do not produce contour tones on the initial syllable. This could be an accidental gap due to the limited number of samples, but it may also be a principled restriction, as word-initial syllable is not affected by the same degree of lengthening as the final syllable.

2.3.3 Melodies in tone sandhi

Finally, tonal melodies are also useful in languages in which the tone sandhi behavior of polysyllabic words is determined by the lexical tone on one of the syllables. The Shanghai example we have seen in §1 is a case in point. The data patterns are repeated in (27). Such patterns again require alignment constraints in OT, which enforce either the docking of the initial and end pitches of a lexical contour tone to the left and right edges of a bigger prosodic domain, as in Shanghai, or one-to-one, left-to-right mapping of the pitch components of a lexical contour tone to syllables in a bigger domain, with or without a boundary tone at the end of the domain.

(27) Shanghai tone sandhi:

σ_1	$\sigma_1\sigma$	$\sigma_1\sigma\sigma$	$\sigma_1\sigma\sigma\sigma$
HL	H-L	H-M-L	H-M-L [↑] -L
MH	M-H	M-H-L	M-H-M-L
LH	L-H	L-H-L	L-H-M-L

Tangxic (Tangxi) (Kennedy 1953), another northern Wu dialect of Chinese, illustrates the left-to-right spreading of a dominant tone in a cleaner way. There are three lexical tones in Tangxic: 33, 51, and 24. In adjective-noun compounds, the underlying tones of non-initial syllables are lost and the tone of the initial syllable is spread across the entire compound. This is shown in (28).⁸

⁸ All data are from Kennedy (1953). Non-IPA symbols have been adapted to IPA according to Kennedy's descriptions.

(28) Tangsɿc tone sandhi in adjective-noun compounds:

- a. 33-T → 33-33:
 kɔ33-sɛ33 → kɔ33-sɛ33 ‘high mountain’
 high-mountain
 tsoŋ33-njin24 → tsoŋ33-njin33 ‘middleman’
 middle-person
 pən33-sɛ51 → pən33-sɛ33 ‘ice water’
 ice-water
- b. 51-T → 53-31:
 ka51-sɛ33 → ka53-sɛ31 ‘rockery’
 artificial-mountain
 sjɔ51-njin24 → sjɔ53-njin31 ‘children’
 small-person
 kwən51-sɛ51 → kwən53-sɛ31 ‘boiling water’
 boiling-water
- c. 24-T → 22-44 (22-24 for slow or effeminate speech):
 du24-sɛ33 → du22-sɛ44 ‘large mountain’
 large-mountain
 du24-njin24 → du22-njin44 ‘adults’
 large-person
 ts^hɔ24-sɛ51 → ts^hɔ22-sɛ44 ‘smelly water’
 smelly-water

Arguably, there are also Chinese dialects in which the tonal contour of the final syllable is preserved and spread across the word. They are often referred to as ‘right-dominant’ dialects. Citing Zheng-Zhang (1964), Yue-Hashimoto (1987) lists Wenzhou as an example. But Yue-Hashimoto acknowledges that the sandhi pattern in Wenzhou is much more complicated than can be summarized as melody spreading. In fact, ‘right-dominant’ dialects primarily have contour leveling and reduction on nonfinal syllables and cannot be appropriately captured by right-to-left melody spreading. I come back to this issue in §5.3.

3. The phonetic underpinnings of contour tone distribution

The cases discussed in §2 have shown that the distributional properties of contour tones — that they preferentially occur in prosodic-final syllable and syllables in shorter words — are not necessarily the epiphenomena of one-to-one, left-to-right tonal melody mapping, and I have hinted at the durational basis for these properties. In this section, I further spell out the phonetic underpinnings of these crosslinguistic patterns of contour tone distribution. These points are made in further detail in Zhang (2002, 2004a).

3.1 The importance of duration in contour tone bearing

Tone bearing ability, especially contour tone bearing ability, is crucially dependent on duration. This is determined by both the production and perception of contour tones.

The production of contour tones crucially differs from that of other complex segments that require more than one oral constrictions (e.g., [k̠p] in Yoruba or clicks in Khoisan languages) in that for contour tones, the acoustic change results from the state change of one single articulator — the vocal folds. Therefore the laryngeal muscle contraction and relaxation, which determine the vocal fold tension (Ohala 1978), must be sequenced to produce the pitch variation in a contour tone. This determines that, unlike a complex segment whose different oral constrictions can be separately planned and overlapped, a contour tone requires sufficient duration to be implemented. More specifically, a complicated contour tone, which involves more pitch targets, would involve more complicated muscle state change, and thus prefer a longer duration to facilitate implementation; a contour tone with farther-apart pitch targets would require the muscles to contract or relax to a greater degree, and thus also prefer a greater duration of its carrier (Sundberg 1979, Xu & Sun 2002).

Perceptually, contour tones are different from other contour segments such as prenasalized stops and affricates. Although the production of the latter group of sounds also requires one articulator to go from one position to another, the acoustic consequence of such change is sudden; e.g., the frication noise is formed the moment the oral occlusion is loosened, and the transition between the two states has no perceptual consequence. But for contour tones, the gradual stretch or relaxation of the vocal folds has a continuous acoustic effect, and the transition from the beginning state to the end state carries a significant perceptual weight in the identification of the tonal contour (Gandour 1978, Gandour & Harshman 1978). This determines that a longer duration is preferred for contour tones, since studies have shown that the perception of such gradual pitch change is enhanced when the duration on which the change is realized is longer. For example, Greenberg & Zee (1979) showed that given the same pitch excursion, the longer the duration of the vowel, the more ‘contour-like’ the tone is perceived by the listener. They also found that listeners cannot perceived pitch changes reliably when the duration is below 90ms.

In the following two sections, I identify the word-final syllable and syllables in shorter words as durationally advantageous. This allows them to serve as better contour tone licensors.

3.2 Final lengthening

A rich body of phonetic literature has shown that the final syllable of a prosodic unit in English is subject to lengthening (Oller 1973, Klatt 1975, Cooper & Paccia-

Cooper 1980, Beckman & Edwards 1990, Edwards, Beckman, & Fletcher 1991, Wightman et al. 1992, Byrd 2000, among others). This effect is also crosslinguistically well attested. Johnson & Martin (2001) list the following languages in which prosodic-final lengthening has been found: Swedish, Dutch, German, Spanish, French, Italian, Russian, Czech, Finnish, Hungarian, Mandarin, Japanese, Hebrew, and Muskogee Creek. Final lengthening has also been documented for Welsh (Williams 1985, 1989), Korean (Cho & Keating 2001), Tagalog (Zhang 2001), Fuzhou Chinese (Zhang 2001), and Xhosa (Zhang 2002). Although the organization of the prosodic hierarchy remains controversial (Selkirk 1984, Nespor & Vogel 1986, Beckman & Pierrehumbert 1986, Pierrehumbert & Beckman 1988, among others), it is a generally agreed upon that bigger prosodic boundaries induce greater lengthening effects (Oller 1973, Klatt 1975, Beckman & Edwards 1990, Wightman et al. 1992, Hofhuis, Gussenhoven, & Rietveld 1995, Byrd 2000, Cho & Keating 2001). In fact, most of final lengthening reported in the literature represents utterance-final lengthening. Therefore, there is a discrepancy between this final lengthening effect and the gravitation of contour tones to the final syllable of lexical words.

Non-prepausal word-final lengthening, however, has also been documented in the literature. Oller (1973) tested the lengthening effects in utterance-final ('It was a [bab].'), phrase-final ('The [bab] is on the table. '), and word-final ('The [bab] apple is on the table. ') positions and found that although utterance-final position has the greatest lengthening effect, phrase-final and word-final syllables also benefit from significant lengthening. A similar experiment by Lindblom (1968) on Swedish reported similar results. Klatt (1975), in an acoustic analysis of a connected discourse consisting of 13 sentences, 236 words, and around 1200 segments, found that the average percentage change in duration from the median duration for a vowel is +30% for word-final and phrase-final position, -2% for word-final but non-phrase-final position, -8% for phrase-final word but non-word-final syllable, and -12% for neither word-final nor phrase-final position. This indicates that non-prepausal word-final syllables are longer than non-word-final syllables in either phrase-final or non-phrase-final words. Beckman & Edwards (1990) compared the duration of [ɑ] in *Pop* and *Poppa* in the following two sentences: '*Pop opposed the question strongly, and so refused to answer it,*' and '*Poppa posed the question strongly, and then refused to answer it,*' and found that duration of [ɑ] in *Pop* is significantly longer than that in *Poppa* for many subjects at many speaking rates. They also found that the duration of [ə] in *Poppa* in the second sentence to be significantly longer than that in *opposed* in the first sentence, indicating that the durational difference is due to final lengthening, not polysyllabic shortening (see §3.2). Given that it is unlikely that there is an phrase boundary after *Pop* or *Poppa*, their data illustrate that there is indeed final lengthening on the word level. Lehiste (1960), in her acoustic study of internal junctures in English, found that the durations of [aj] and [u] in *Nye trait* and *two lips* are greater than those in *nitrate* and *tulips*, respectively, presumably due to the presence of a word boundary in the former.

Moreover, unlike non-word-final syllables, a word-final syllable also has opportunities to occur before bigger prosodic boundaries. Therefore, the average duration of a word-final syllable in a connected discourse will be greater than that of the same syllable in non-prepausal positions alone. This point can be illustrated by the acoustic data from Crystal & House (1982, 1988), which are composed of both slow and fast readings of two English scripts, each composed of around 300 syllables, by various numbers of speakers. The long vowels [i, e, æ, ɑ, o, ɔ, u] and short vowels [ɪ, ε, ʌ, ʊ] are considerably longer in word-final position, which includes both nonprepausal and prepausal positions, than their average durations in all positions: the long vowels average 138ms and 154ms before word-final stops and fricatives respectively, but only 128ms and 118ms before stops and fricatives in general; the short vowels average 81ms and 71ms before word-final stops and fricatives respectively, but only 63ms and 69ms before stops and fricatives in general.

Therefore, although word-final lengthening is admittedly less well documented and smaller in degree than phrase- and utterance-final lengthening, it still exists and hence can serve as the phonetic basis for the gravitation of contour tones to the final syllable of a word. The reason that it seems to have a greater effect on contour tone licensing than phrase- or utterance-final lengthening, I believe, is related to paradigm uniformity (Kiparsky 1982, Bybee 1988, Burzio 1994, Kenstowicz 1997, Steriade 2000, among others). A word-final syllable will always be word-final, but only occasionally, if ever, be phrase- or utterance-final. Therefore, a phonology that bases its contour tone licensing decision on the word level has a better chance at minimizing alternation.

Finally, phrase- and utterance-final lengthening in fact does have phonological effects on contour tone licensing in some languages. For example, in Kikuyu (1), the LH rise only surfaces when the syllable is phrase-final, but simplifies to H otherwise; in Beijing Chinese (§2.1.1), the complex contour 213 only surfaces in utterance-final position and simplifies to 35 or 21 in other positions. These cases illustrate that the effect of phrase- or utterance-final lengthening can override the preference for paradigm uniformity to allow contour tones to surface only in these final positions, as Optimality Theory would predict.

3.3 Polysyllabic shortening

The shortening of syllables in polysyllabic words has also been well documented in the literature (Lehiste 1972, Klatt 1976, Lindblom & Rapp 1973, Lindblom, Lyberg, & Holmgren 1981, Lyberg 1977, Strangert 1985).

Lehiste (1972) studied the vowel duration differences among monosyllabic words (e.g., *sleep*, *shade*) and their morphological derivatives of various lengths (e.g., *sleepy*, *sleepiness*; *shady*, *shadiness*). Although the biggest effect she found was that the vowels in monosyllabic words are longer than those in longer words, which could be attributed to final lengthening, she also found the initial vowel of a

disyllabic word is longer than that of a trisyllabic word, indicating that polysyllabic shortening indeed exists. Based on the results of Lehiste (1975), Klatt (1976), in his modeling of the durational behavior in English, designated a 15% shortening effect for vowels in polysyllabic words.

Polysyllabic shortening has also been consistently reported in a number of careful phonetic studies of Swedish (Lindblom & Rapp 1973, Lindblom, Lyberg, & Holmgren 1981, Lyberg 1977, Strangert 1985). For example, Lyberg (1977) found that the duration of stressed [ɑ:] with an acute accent decreases with the increase of the number of syllables following the [ɑ:] in the word. Strangert (1985) further showed that the shortening effect in longer words is also operative on the phrasal level. Moreover, Strangert (1985) listed the following languages in which polysyllabic shortening had been documented: English, Dutch, German, Spanish, French, Lappish, Finnish, Hungarian, and Estonian.

Polysyllabic shortening puts the syllables in polysyllabic words at a disadvantage for contour tone licensing. In other words, syllables in shorter words, in particular, monosyllabic words, are better contour tone licensors due to their inherent longer duration.

3.4 The relevance of final lengthening and polysyllabic shortening

Although final lengthening and polysyllabic shortening are both crosslinguistically well attested, the magnitude of these effects varies from language to language (Delattre 1966, Hallé et al. 1991, Johnson & Martin 2001, Strangert 1985). Moreover, for many tone languages for which we know the distribution of contour tones, including some under discussion here, there is no available phonetic data that verify the presence of these durational effects. Therefore, care should be taken to justify the claim that it is these durational effects that govern the gravitation of contour tones to word-final syllable and syllables in shorter words.

There are two reasons which suggest that the presence of these durational effects is universal. First, although studies have found that the MAGNITUDE of these effects is language-specific, no study has reported the complete LACK of these effects. This is particularly true for final lengthening, which has been documented for many languages in different language phyla. Second, the suggested reasons for these effects have been invariably functional in nature. For example, Klatt (1976) considered both speech perception and production as the bases for final lengthening. Perceptually, the durational cues at prosodic boundaries can help the listener process the prosodic and syntactic structure of the utterance. Production-wise, the slowing down at the end of phrases may be due to the decreasing number of words that needs to be produced from a hypothesized phrase buffer; it may also help the speaker plan the next phrase to be uttered (p.138). Strangert (1985) considered isochrony among words as the reason for polysyllabic shortening, citing Fraise (1982), who showed that when asked to

produce groups of four taps, subjects shortened the intervals between taps as compared to when they were asked to produce groups of two taps. If these are the motivations for the durational effects under discussion, then there is no reason to think that they will only be applicable to some languages, but not others.

3.5 Phonological works that recognize the effect of duration on contour tone licensing

The durational basis of contour tone licensing has been most notably explored in works by Woo (1969) and Duanmu (1990, 1993, 1994a, b). Woo (1969) proposed that contour tones are sequences of level tones representationally, and each level tone needs a rime segment to be licensed. This accounts for the direct relation between the length of a syllable and the kinds of tones it can carry. Duanmu further proposed that the tone bearing unit is the mora, and contour tones are only allowed on bimoraic syllables. This captures the dichotomy behavior of Chinese languages: one type, represented by Mandarin and Cantonese, has coda contrasts, diphthongs, longer rime duration, and consequently few distributional restrictions on contour tones; the other type, represented by Shanghai and Suzhou, has no coda contrasts, no diphthongs, shorter rime duration, and consequently many tone sandhi processes that turn contour tones into level tones. Zhang (2002, 2004b) took the position further by arguing that the mora, as a phonological contrastive length or weight unit, is insufficient in capturing the crosslinguistic patterns of contour tone licensing; durational properties on a more detailed phonetic level must be available to phonology to allow a unified account for all durationally related patterns of contour tone distribution. This is the position taken in this paper as well.

4. The analyses of distinctive and nondistinctive tonal associations in Optimality Theory

In §2, we have seen two major types of languages. One is languages like Beijing Chinese, Ron Phibun Thai, and Mende, in which the association between tones and TBUs is contrastive, and the distinctive association is established through the irrelevance of tonal melodies in a domain larger than the syllable. The other type is languages in which tonal melodies are indeed relevant, such as Kukuya, which has lexical melodies, and Kanakuru and Hausa, which have morphological melodies. In this section, I provide Optimality-Theoretic analyses for both types of languages, using Mende and Kukuya as examples. The goal is to show that for both types of languages, the analysis needs to specifically refer to the durational advantage of syllables in prosodic-final position and in shorter words. Crucially, recapitulating the Association Conventions and Wellformedness Condition in constraint format does not provide a viable analysis for the preferred locations of contours, even for languages in which tonal melodies are motivated. In other words, relying solely on melody mapping does not only result in a dichotomy in the analysis of a uniform phenomenon, but is also technically impossible.

4.1 Distinctive tonal association — Mende

The distinctiveness of tonal association in Mende is established through examples in (18), which show that H-L vs. H-HL contrast for disyllables and H-L-L and H-H-L as well as L-H-H and L-L-H contrast for trisyllables. Taken together with the additional tonal patterns such as HLH and HLHL identified by Dwyer (17), this constitutes the major argument for durational factors rather than tonal melody mapping as the basis for contour tone distribution in Mende.

To account for Mende, I define the tonal markedness constraint family in (29) and posit intrinsic rankings of the constraints in (30).

(29) *CONTOUR_{*i*}-σ_{*j*}: contour *i* cannot occur on syllable type *j*.

- (30) a. If the sonorous portion of the rime in σ_{*m*} is longer than σ_{*j*}, then *CONTOUR_{*i*}-σ_{*j*} » *CONTOUR_{*i*}-σ_{*m*}.
- b. If contour *i* requires a longer sonorous rime duration than contour *n*, then *CONTOUR_{*i*}-σ_{*j*} » *CONTOUR_{*n*}-σ_{*j*}.

The ranking in (30a) ensures that a contour tone is allowed on a longer syllable before it is allowed on a shorter syllable, and the ranking in (30b) ensures that a syllable allows a contour that requires a shorter duration before it allows a contour that requires a longer duration. Both of these rankings are projected from phonetics. For detailed discussions on the contour tone bearing ability of syllables and the complexity of tonal contours that decides the duration required for their implementation, see Zhang (2002).

Specifically for Mende, the relevant contour types, in descending complexity in terms of the sonorous rime duration required, are LHL, LH, and HL.⁹ The sonorous rime duration of the syllables in Mende is systematically affected by three parameters: vowel length (σ_{VV}>σ_V), position of the syllable in the word (σ_{final}>σ_{nonfinal}), and syllable count in the word (σ_{monosyllabic}>σ_{polysyllabic}, where ‘polysyllabic’ here means two or more syllables). If we assume that on the word level, the shortest long vowels are still longer than the longest short vowels, then the syllable types in Mende can be ordered in descending sonorous rime duration as: σ_{VV-monosyllabic}, σ_{VV-polysyllabic-final}, σ_{VV-polysyllabic-nonfinal}, σ_{V-monosyllabic}, σ_{V-polysyllabic-final}, and σ_{V-polysyllabic-nonfinal}.¹⁰ Therefore, the relevant constraints in the

⁹ The LH vs. HL difference stems from Sunberg (1979)’s and Xu & Sun (2002)’s finding that rising tones take longer to implement than falling tones of equal pitch excursion.

¹⁰ Lacking phonetic data in Mende, we cannot verify the assumption about the durational comparison between long and short vowels. But data from other languages indicate that this is not an unreasonable assumption. Crosslinguistically, contrastive long vowels are generally about twice as long as short vowels (Lehiste 1970). Lehiste reports data from Danish (V:/V=1.98), Finnish (V:/V=2.27), Serbo-Croatian (V:/V=1.49), Thai (V:/V=2 to 3.57), and Swedish (V:/V=1.25 to 1.85) in support of this claim. Data from Creek (Johnson & Martin 2001), Dutch (Jongman 1998), Thai (Abramson & Ren 1990), Hindi, Malayalam,

*CONTOUR_i-σ_j constraint family and their intrinsic rankings in Mende can be shown as in (31). MS=monosyllabic, PS=polysyllabic, F=final, NF=nonfinal.

(31) Mende *CONTOUR_i-σ_j constraint family:

*LHL-	»	*LHL-	»	*LHL-	»	*LHL-	»	*LHL-	»	*LHL-
σ _V -PS-NF		σ _V -PS-F		σ _V -MS		σ _{VV} -PS-NF		σ _{VV} -PS-F		σ _{VV} -MS
∇		∇		∇		∇		∇		∇
*LH-	»	*LH-	»	*LH-	»	*LH-	»	*LH-	»	*LH-
σ _V -PS-NF		σ _V -PS-F		σ _V -MS		σ _{VV} -PS-NF		σ _{VV} -PS-F		σ _{VV} -MS
∇		∇		∇		∇		∇		∇
*HL-	»	*HL-	»	*HL-	»	*HL-	»	*HL-	»	*HL-
σ _V -PS-NF		σ _V -PS-F		σ _V -MS		σ _{VV} -PS-NF		σ _{VV} -PS-F		σ _{VV} -MS

To complete the analysis for Mende, I also define two tonal faithfulness constraints MAX(tone) and IDENT(tone), as in (32).

- (32) a. MAX(tone): if T is a tone in the input, then T has an identical correspondent in the output.
- b. IDENT(tone): if α is a TBU in the input and β is a correspondent of α in the output, then the tonal specification of α must be identical to the tonal specification of β.

The difference between MAX(tone) and IDENT(tone) is in the satisfaction of the constraint when the underlying tones have been reassociated to the Tone-

and Arabic dialects (Broselow, Chen, & Huffman 1997) also show that the duration of long vowels falls in the range of 1.5 to 2.5 times the duration of short vowels. The lengthening effects in word-final syllable and syllables in shorter words, however, are smaller. In Lehiste (1972) (see discussion in §3.3), although she found that the vowels in monosyllabic words, which benefited from being in both the final position and shorter words, were between 1.4 to 2.3 times of the duration of the same vowels in polysyllabic morphological derivatives, given that the words were read in isolation and thus benefited from *utterance-final* lengthening, the combined duration contribution of *word-final* lengthening and being in shorter words would be much smaller. Klatt (1973) compared the vowel duration of monosyllabic words and the nonfinal syllable of disyllabic words in English and found that the former averages 1.2 to 1.5 times the latter. Klatt (1976), in his modeling of the durational behavior in English, designated 35% and 15% shortening for vowels in non-phrase-final positions and polysyllabic words, respectively, and recognized that the durational discrepancy between final and nonfinal vowels on the word level would be much smaller. Direct durational comparisons between short vowels and long vowels in a number of languages have also shown that long vowels are generally longer than short vowels even when they are in positions of prosodic disadvantage. Johnson & Martin (2001) showed that word-initial long vowels are considerably longer than word-final short vowels in Creek. Hofhuis, Gussenhoven, & Rietveld (1995) showed that Dutch vowels are lengthened before prosodic boundaries, and the effect gets progressive bigger from the prosodic word boundary to the utterance boundary; but the long vowels before a prosodic word boundary are still longer than the short vowels before an utterance boundary. de Jong & Zawaydeh (2002) showed that in Ammani-Jordanian Arabic, long vowels are considerably longer than short vowels even when the latter benefit from stress lengthening and focus lengthening while the former do not. Lehtonen (1970) measured the durations of short and long vowels in various positions of one-, two-, and three-syllable words in Finnish and found that long vowels in any position are longer than short vowels in any position.

Bearing Units due to the loss of TBU, spreading, or other reasons. IDENT(tone) will be violated if reassociation such as LH-L to L-HL occurs, since the tonal specifications for both syllables have been changed; but MAX(tone) is satisfied since all tonal targets are preserved from the input to the output. The comparison is similar to that of MAX(F) and IDENT(F) in Zhang (2000b). Intuitively, IDENT(tone) serves a more important purpose in languages with distinctive association than in languages with nondistinctive association.

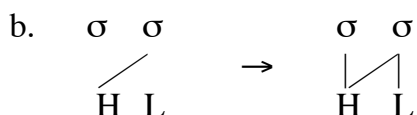
To rank the tonal faithfulness constraints against the *CONTOUR_{i-σ_j} family, we rely on the generalizations in (22). For example, for LHL, since it can only occur on a long vowel in a monosyllabic word, for the first row of markedness constraints in (31), tonal faithfulness should be ranked just above *LHL-σ_{VV}-MS; we can likewise decide the ranking between tonal faithfulness and the markedness constraints for LH and HL. The crucial ranking for Mende is summarized in (33), and the tableaux in (34) serve as an illustration for the ranking: if a prelinking in the input incurs a violation of a highly ranked tonal markedness constraint, then the prelinking is not preserved (34a); but if a prelinking does not result in violation of highly ranked markedness constraints, then the prelinking is preserved (34b). Note that (34) does not make claims about the UR's of òô and óô; it is only meant to illustrate that a particular contour tone will not surface on an undesirable syllable even if a UR in the Rich Base (Prince and Smolensky 1993) encourages it to do so.

(33) Mende ranking:

*LHL-σ _V -PS-NF *LHL-σ _V -PS-F *LHL-σ _V -MS *LHL-σ _{VV} -PS-NF *LHL-σ _{VV} -PS-F *LH-σ _V -PS-NF *LH-σ _V -PS-F *HL-σ _V -PS-NF	»	MAX(tone) IDENT(tone)	»	*LHL-σ _{VV} -MS *LH-σ _V -MS *LH-σ _{VV} -PS-NF *LH-σ _{VV} -PS-F *LH-σ _{VV} -MS *HL-σ _V -PS-F *HL-σ _V -MS *HL-σ _{VV} -PS-NF *HL-σ _{VV} -PS-F *HL-σ _{VV} -MS
---	---	--------------------------	---	--

(34) a. $\begin{array}{ccc} \sigma & \sigma & \\ & \diagdown & / \\ & L & H & L \end{array} \rightarrow \begin{array}{ccc} \sigma & \sigma & \\ | & / & \diagdown \\ L & H & L \end{array}$

	*LH- σ V-PS-NF	IDENT(tone)	*HL- σ V-PS-F
$\begin{array}{c} \sigma \quad \sigma \\ \diagdown \quad \diagup \\ L \quad H \quad L \end{array}$	*!		
$\begin{array}{c} \sigma \quad \sigma \\ \downarrow \quad \diagdown \\ L \quad H \quad L \end{array}$		*	*



	*LH- σ V-PS-NF	IDENT(tone)	*HL- σ V-PS-F
$\begin{array}{c} \sigma \quad \sigma \\ \diagdown \quad \diagup \\ H \quad L \end{array}$			*
$\begin{array}{c} \sigma \quad \sigma \\ \downarrow \quad \downarrow \\ H \quad L \end{array}$		*!	

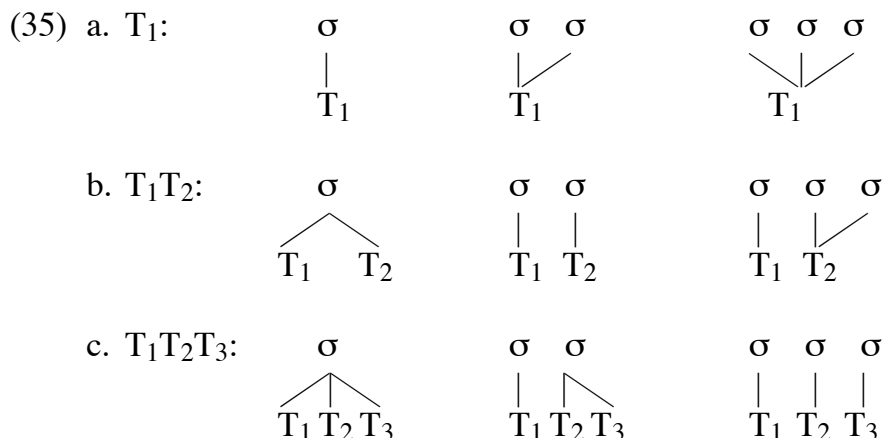
As we can see from this sample analysis, for a representative language with distinctive tonal association, the analysis must refer to the final position as well as the syllable count in the word in order to account for its distribution of contour tones.

In adherence to Richness of the Base, we must also consider inputs that include contour tones that are either in principle or accidentally missing (e.g., HLHL, HLH). To ensure that they do not surface, there must be highly ranked markedness constraints that prevent their faithfulness rendition, and these constraints and their ranking can be either deduced from phonetic principles in (30) or learned from the exposure to data.

4.2 Nondistinctive tonal association — Kukuya

The Kukuya tonal patterns can be summarized as follows: five word melodies — L, H, LH, HL, and LHL — map onto syllables one-to-one, left-to-right, with the exception that LH maps onto trisyllables as L-L-H, not L-H-H. I provide the analysis to Kukuya in two steps accordingly. The first step illustrates that in order to capture the canonical output of the Association Conventions, an Optimality Theoretic analysis must identify the final syllable as a privileged contour tone carrier; alignment constraints alone cannot replicate the mapping procedure in derivational terms. The second step uses Zoll (2003)'s *CLASH to capture the L-L-H mapping.

To proceed with the first step, let us consider a slightly more abstract scenario in which melodies composed one, two, or three tonal targets are mapped onto mono-, di-, or trisyllabic words as in (35).



The following observations, which are canonical of tonal melody mapping, obtain: the tone-to-TBU association is nondistinctive, e.g., there is no contrast between L-H-H and L-L-H on trisyllables; and contour tones only surface on word-final syllables.

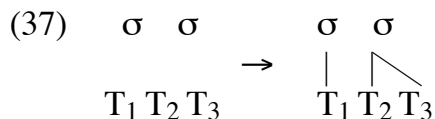
The nondistinctiveness of association can be accounted for by the low ranking of IDENT(tone). Provided that MAX(tone) is highly ranked, all the tonal targets will be preserved, and their association with TBUs will be determined by markedness constraints outlined below.

As discussed above, under the traditional mapping mechanism, the gravitation of contour tones to word-final syllables is an epiphenomenon unrelated to the extra duration as a result of final lengthening. In this spirit, we may attempt to translate the mapping procedure into OT without referring to the durational advantage of the final syllable. One possible approach is to use an alignment constraint, which requires tones to align to the right edge of a word, as defined in (36). This is a gradient constraint: if the right edge of a tone is separated from the right edge of the word by n syllables, the constraint accumulates n violations.

(36) ALIGN(Tone, R, Word, R) (abbr. ALIGN-R):

The right edge of a tone must align with the right edge of a word.

The effect of the ALIGN-R constraint can be seen in the tableau in (37). The winner, which has a contour on the final syllable, satisfies ALIGN-R better than the losing candidate, which has a contour on the initial syllable.



	ALIGN-R
	*
	**!

To rule out the possibility of aligning all the tones to the rightmost syllable, we must also posit markedness constraints against contour tones, as in (38).

- (38) a. $*T_1T_2$: no HL or LH contour is allowed on any syllable.
 b. $*T_1T_2T_3$: no HLH or LHL contour is allowed on any syllable.

These constraints must outrank ALIGN-R to avoid unnecessary contours, but must be outranked by MAX(tone) to allow contours to surface when there is no choice. The tableaux in (39) illustrate these effects.

- (39) a. $\sigma \quad \sigma$ → $\sigma \quad \sigma$
 $T_1 T_2 T_3$ $T_1 T_2 T_3$

	MAX(tone)	$*T_1T_2T_3$	ALIGN-R
			*
		*!	

- b. σ → σ
 $T_1 T_2 T_3$ $T_1 T_2 T_3$

	MAX(tone)	$*T_1T_2T_3$	ALIGN-R
		*	
	*!		

We are therefore led to the constraint ranking in (40). I have omitted obvious markedness constraints such as $*T_1T_2T_3T_4$, which bans extremely complex

contour tones, and $*T_1T_2T_3T_4$ -WORD, which bans unattested tonal melodies. These constraints must be undominated.

(40) $\text{MAX}(\text{tone}) \gg *T_1T_2T_3, *T_1T_2 \gg \text{ALIGN-R} \gg \text{IDENT}(\text{tone})$

But this constraint ranking makes the wrong prediction for the mapping of a two-tone melody onto three syllables, as shown in (41). The winning candidate is the one that realizes T_1 on the first two syllables and T_2 on the last syllable. It satisfies ALIGN-R better than the actual output since the right edge of T_1 is closer to the right edge of the word.

(41) $\sigma \ \sigma \ \sigma \rightarrow \begin{array}{ccc} \sigma & \sigma & \sigma \\ | & / & \\ T_1 & T_2 & \end{array}$

	MAX(tone)	$*T_1T_2$	ALIGN-R
$\begin{array}{ccc} \sigma & \sigma & \sigma \\ & / & \\ T_1 & T_2 & \end{array}$			**!
$\begin{array}{ccc} \sigma & \sigma & \sigma \\ / & & \\ T_1 & & T_2 \end{array}$			*

We may try to remedy the situation by positing an ALIGN-L constraint, as defined in (42). As ALIGN-R , it is also a gradient constraint. If we rank ALIGN-L over ALIGN-R , we derive the correct output for (41), as shown in (43).

(42) $\text{ALIGN}(\text{Tone}, \text{L}, \text{Word}, \text{L})$ (abbr. ALIGN-L):

The left edge of a tone must align with the left edge of a word.

(43) $\sigma \ \sigma \ \sigma \rightarrow \begin{array}{ccc} \sigma & \sigma & \sigma \\ | & / & \\ T_1 & T_2 & \end{array}$

	MAX(tone)	$*T_1T_2$	ALIGN-L	ALIGN-R
$\begin{array}{ccc} \sigma & \sigma & \sigma \\ & / & \\ T_1 & T_2 & \end{array}$			*	**
$\begin{array}{ccc} \sigma & \sigma & \sigma \\ / & & \\ T_1 & & T_2 \end{array}$			**!	*

But we observe immediately that the tableau in (39a) now gives the wrong result — the contour tone now occurs on the initial syllable instead of the final

syllable, as shown in (44). Notice that both candidates violate $*T_1T_2$, which penalizes contour tones with two pitch targets.

$$(44) \quad \begin{array}{ccc} \sigma & \sigma & \\ T_1 & T_2 & T_3 \end{array} \rightarrow \begin{array}{ccc} \sigma & \sigma & \\ | & / & \\ T_1 & T_2 & T_3 \end{array}$$

	MAX(tone)	$*T_1T_2$	ALIGN-L	ALIGN-R
$\begin{array}{ccc} \sigma & \sigma & \\ & / & \\ T_1 & T_2 & T_3 \end{array}$		*	**!	*
$\begin{array}{ccc} \sigma & \sigma & \\ / & & \\ T_1 & T_2 & T_3 \end{array}$		*	*	**

The problem here is conceptual rather than technical. The conflict lies between the left-to-right mapping mechanism, which requires a higher ranking of ALIGN-L, and the attraction of contours to the final syllable, which requires a higher ranking of ALIGN-R. Therefore, in order for the analysis to work, the desired effect of ONE of the ALIGN constraints must be achieved by other means. I propose that ALIGN-R should be eliminated from the constraint hierarchy, and that its effect should be achieved by referring to the final syllable in the word as a privileged position for contour-bearing.

Let me first show that this is a technically viable solution. In lieu of ALIGN-R, we consider two positional markedness constraints $*T_1T_2-\sigma_{\text{nonfinal}}$ and $*T_1T_2T_3-\sigma_{\text{nonfinal}}$, as defined in (45).

- (45) a. $*T_1T_2-\sigma_{\text{nonfinal}}$: no HL or LH contour is allowed on a nonfinal syllable.
 b. $*T_1T_2T_3-\sigma_{\text{nonfinal}}$: no HLH or LHL contour is allowed on a nonfinal syllable.

The ranking $*T_1T_2T_3-\sigma_{\text{nonfinal}}, *T_1T_2-\sigma_{\text{nonfinal}} \gg \text{ALIGN-L}$ ensures that tones are aligned as close to the left edge as possible, provided contour tones do not surface on nonfinal syllables. This is illustrated in the tableaux in (46). MAX(tone) is still assumed to be highly ranked, and it is only outranked by undominated tonal markedness constraints such as $*T_1T_2T_3T_4$ and $*T_1T_2T_3T_4\text{-WORD}$.

$$(46) \text{ a. } \begin{array}{ccc} \sigma & \sigma & \sigma \\ T_1 & T_2 & \end{array} \rightarrow \begin{array}{ccc} \sigma & \sigma & \sigma \\ | & / & \\ T_1 & T_2 & \end{array}$$

	*T ₁ T ₂ T ₃ - σ _{nonfinal}	*T ₁ T ₂ - σ _{nonfinal}	*T ₁ T ₂ T ₃	*T ₁ T ₂	ALIGN-L
					*
					**!

$$\begin{array}{ccc}
 \text{b.} & \sigma & \sigma \\
 & \text{T}_1 & \text{T}_2 & \text{T}_3 \\
 & & \rightarrow & \begin{array}{ccc} \sigma & \sigma \\ | & \diagdown \\ \text{T}_1 & \text{T}_2 & \text{T}_3 \end{array}
 \end{array}$$

	*T ₁ T ₂ T ₃ - σ _{nonfinal}	*T ₁ T ₂ - σ _{nonfinal}	*T ₁ T ₂ T ₃	*T ₁ T ₂	ALIGN-L
				*	**
		*!		*	*
	*!	*		*	

Therefore, the ranking in (47) accounts for the abstract tonal patterns in (35).

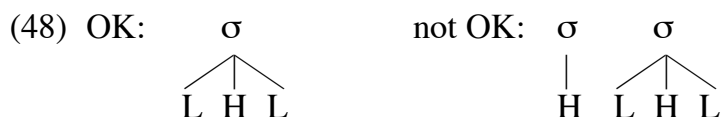
$$(47) \ *T_1T_2T_3T_4, \ *T_1T_2T_3T_4\text{-WORD} \gg \text{MAX}(\text{tone}), \ *T_1T_2T_3\text{-}\sigma_{\text{nonfinal}}, \ *T_1T_2\text{-}\sigma_{\text{nonfinal}} \gg \ *T_1T_2T_3, \ *T_1T_2, \ \text{ALIGN-L} \gg \ \text{IDENT}(\text{tone})$$

Another reason for replacing ALIGN-R is that, unlike ALIGN-L, it has no psycholinguistic or phonetic motivation. The motivation for ALIGN-L can be found in numerous psycholinguistic studies that illustrate the importance of word-initial position in lexical access and word recognition. Brown & McNeill (1966) show that in a tip-of-the-tongue state, the initial segment in a word has a higher rate of being recalled by subjects than other segments; Horowitz, White, & Atwood (1968) and Horowitz, Chilian, & Dunnigan (1969) show that utterance-initial materials provide better cues for word recognition and lexical retrieval than medial or final materials; and a series of studies by Marslen-Wilson and colleagues illustrate the significance of beginnings of words in psycholinguistic tasks such as close-shadowing and cross-modal priming (Marslen-Wilson & Welsh 1978, Marslen-Wilson & Tyler 1980, Marslen-Wilson & Zwitserlood 1989, among others; also see summary in Marslen-Wilson 1989). The psycholinguistic prominence of the initial position motivates the realization of contrastive

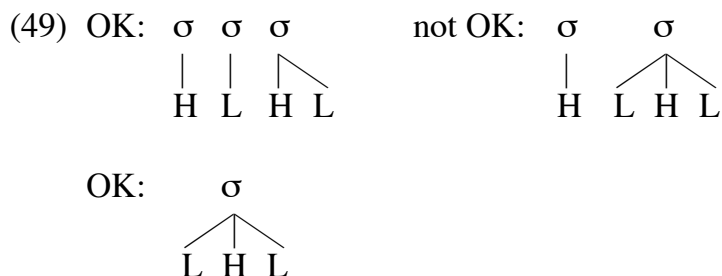
information early in the word, and the gradient nature of ALIGN-L mirrors the preference to have such information as early as possible. The right edge of the word, however, does not have the same kind of processing advantage as the left edge. The only advantage — duration — is more aptly captured by markedness constraints that penalize contour tones on positions that do not have this advantage, as final lengthening generally does not affect the penultimate or earlier syllables, and hence should not be captured by a gradient constraint like ALIGN-R.

In short, the resolution to the conflict between ALIGN-L and ALIGN-R is: tones prefer to occur closer to the left edge of the word for the ease of processing, and it can be captured by ALIGN-L; but CONTOUR tones prefer to occur on the final syllable because of its extended duration, and it can be captured by *CONTOUR- σ_{nonfinal} .

The abstract data pattern above does not establish the need to refer to word length to account for the fact that syllables in shorter words are more tolerant of contour tones. For example, that the complex contour LHL can occur on monosyllabic words, but not on syllables of disyllabic words, can be due to the fact that LHL is a possible tonal melody while HLHL is not, as shown in (48). Therefore the data pattern can be captured by positing a high-ranking *HLHL-WORD constraint, without specific mention of word length.



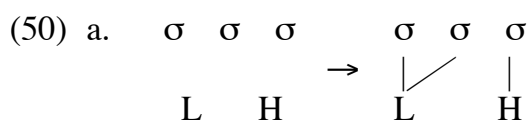
But if HLHL were a possible tonal melody in the language, specifically, if it could be found on polysyllabic words, as shown in (49), then it would be justified to say that the lack of LHL on syllables in disyllabic words is due to a high-ranking constraint *LHL- $\sigma_{\text{disyllabic}}$, which intrinsically outranks *LHL- $\sigma_{\text{monosyllabic}}$. Then when the tonal faithfulness constraint MAX(tone) is ranked between the two, LHL will surface on monosyllabic words, but not on syllables in disyllabic words. The Mende analysis in §4.1 in fact illustrates this point.



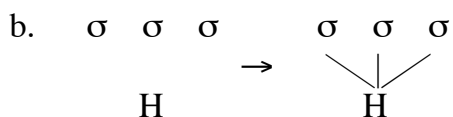
A similar approach to the attraction of contour tones to final syllable has been proposed by Zoll (1997, 1998, 2003). Zoll (1997) uses the constraint ALIGN-R(contour) to capture the gravitation of contour tones to the right edge. As we have seen, this is not an appropriate characterization of the final advantage for

contour tones due to the gradient nature of the constraint. Zoll (1998, 2003) uses licensing constraints COINCIDE(contour, σ), where σ represents syllables with canonically longer duration or greater sonority such as long-voweled, stressed, or final syllables. This account is essentially identical to one proposed above.

To account for the different mappings of LH and HL to trisyllables in Kukuya, I adopt Zoll (2003)'s constraint *CLASH, which bans two adjacent phonetically H-toned syllables. When *CLASH outranks ALIGN-L, but is outranked by DEP(tone), which bans tone insertion, and SPECIFY, which requires a tone bearing unit to be associated with a tone (Yip 2002: p.83), then LH melody will map onto trisyllables as LLH instead of LHH (50a), but H can still map onto trisyllables as HHH (50b).



	*CLASH	ALIGN-L
$\sigma \ \sigma \ \sigma$ / \ L H		*
☞ $\sigma \ \sigma \ \sigma$ / \ L H		**!



	SPECIFY	DEP(tone)	*CLASH	ALIGN-L
$\sigma \ \sigma \ \sigma$ H	*!*			
$\sigma \ \sigma \ \sigma$ / \ H L		*!		*
☞ $\sigma \ \sigma \ \sigma$ / \ H			*	

A shrewd reader may have noticed that, with *CLASH, we can in fact capture the Kukuya pattern with ALIGN-R (\gg ALIGN-L) and no mention of the final advantage for contour tones: the tableau in (44) captures the LH mapping to L-L-H in trisyllables, and *CLASH \gg ALIGN-R will force the HL melody to spread as H-L-L, not H-H-L.

There are three reasons for going through the rather strenuous exercise of capturing the abstract pattern in (35), however. First, as I have argued, there are scenarios in which tonal melodies are relevant, such as morphological marking and tone sandhi. Given that the mapping mechanism is the same regardless of whether the melody is lexical or morphological, there needs to be a general mechanism in Optimality Theory that approximates one-to-one, directional melody mapping in any event. Second, although as Zoll (2003) has shown, exceptionless examples of one-to-one, left-to-right melody mapping are hard to find, its analysis safeguards the theory in case a language with such lexical melodies were to be found — after all, this is the prediction of the traditional autosegmental phonology with derivation. Finally, there is the issue of motivating the constraints external to the phonological pattern: ALIGN-R, as I have argued, lacks such motivation.

In short, I have shown in this section that there is no formal translation of the ruled-based Association Conventions into OT that can dispense with the identification of final syllables and syllables in shorter words as privileged positions for contour tones. Alignment constraints alone do not suffice on either conceptual or technical ground. The mapping is in fact dictated by two conflicting priorities: to have contrastive information as early as possible in the word and to limit time-consuming phonological features to durationally abundant positions. This echoes the analysis of ‘conflicting directionality’ in Zoll (1997).

5 Further supporting evidence — right-to-left mapping does not produce initial preference for contour tones

Further supporting evidence for the relevance of phonetic duration to contour tone distribution comes from the limited cases in which right-to-left melody mapping has been motivated. If the one-to-one, left-to-right mapping mechanism was the explanation for the gravitation of contour tones to prosodic-final syllable, then for languages with right-to-left mapping, we would expect contour tones to preferentially surface on the initial syllable. But in the few languages in which right-to-left mapping has been motivated, no such preference is attested. They either allow contour tones on both initial and non-initial syllables or produce no contour tones by melody mapping. In fact, in the survey reported in Zhang (2002), there is no language in which contour tones gravitate to prosodic-initial syllable when all else is equal. This scenario is in stark contrast with the prevalence of final contour-tone advantage. This discrepancy has a straight-forward explanation, however: vowel lengthening in domain-final syllable is crosslinguistically well attested, and the degree of lengthening is considerable; domain-initial vowel lengthening, however, is rarely found — although Barnes (2002) attests to its effect in Turkish and Cho & Keating (2001) show that it occurs, somewhat inconsistently, in Korean, both Fougeron & Keating (1997) and Bryd (2000) show little evidence of it in English, especially for initial-syllable vowels preceded by onset consonants. If contour tone distribution is predicted by the phonetic

properties of the tone-bearing elements, then the licensing asymmetry between the initial and the ultima is to be expected; but if the directionality of melody mapping is what lies behind the contour restrictions, then this asymmetry would have no explanation.

In contrast to the prevalence of left-to-right melody spreading in the so-called ‘left-dominant’ Chinese dialects, the lack of right-to-left melody spreading in ‘right-dominant’ dialects constitutes a similar argument for the relevance of durationally based *CONTOUR- σ_{nonfinal} constraints to tonal patterns. Without these constraints, we would expect right-to-left spreading to be just as common as the reverse and predict languages in which contour tones preferentially occur on nonfinal syllables, all else being equal.

In the following sections, I discuss Hausa, Kanakuru, Tangsic, and Wenzhou to illustrate these arguments.

5.1 Hausa

The syllables in Hausa can be either open or closed, and there is a vowel length contrast in open syllables. This renders the following syllable types: CVV, CVR, CVO, and CV. There are three lexical tones — H, L, and Fall (HL). H and L can occur on all syllables, while HL can only occur on CVV, CVR, and CVO (Newman 2000).¹¹

Newman (2000) states that ‘(f)alling tone in nonderived disyllabic and polysyllabic words typically occurs on the last syllable.’ (Newman 2000:606) Most of these words are loanwords from English and Arabic. ‘The Fall represents either (a) a truncated H-L disyllabic sequence or (b) an approximation, especially in the case of English loanwords, of the stress/intonation in the source language.’ (Newman 2000:606) These two types of words are exemplified in (51).¹²

¹¹ Newman (2000) considers bimoraicity to be the contour-tone licensing condition, with coda consonant, sonorant or otherwise, being moraic. Zhang (2002, 2004b) argues against bimoraicity as the general licensing condition for contour tones. Specifically for Hausa, both Zhang (2002) and Gordon (1999) show that the CVO syllables that carry the falling tone have a slightly lengthened vowel and a much reduced tonal contour as compared to CVV and CVR. The ability of CVO, but not CV, to carry the fall is possibly due to the ability of the former to lengthen without jeopardizing any vowel length contrast. Zhang (2002) further takes the crosslinguistic different behaviors of CVO in contour tone licensing, e.g., non-contrastive vowel lengthening in Mitla Zapotec, contrastive vowel lengthening in Gã, non-contrastive contour reduction in Pingyao Chinese, contrastive contour reduction in Xhosa, and a combination of vowel lengthening and contour reduction in Hausa, as a factorial typological argument for the Optimality Theoretic constraints encoding non-contrastive durational properties.

¹² All data in this section are from Newman (2000). Non-IPA symbols have been adapted to IPA according to Newman’s phonetic descriptions.

(51) Hausa falling tone in nonderived words (final):

a.	bàmbûs (= bambu:fî:)	‘type of perfume’
	là:dân (= là:da:nì:)	‘muezzin’
	lì:mân (= lì:má:mì:)	‘imam’
	mùtûm (< mùtúmì:)	‘man, person’
	ƴàrîf (= ƴàrí:fì:)	‘holy man’
	zàitûn (= zàitú:nì:)	‘olive (tree)’
b.	àffil	‘legal appeal’
	bà:silîn	‘vaseline’
	filâs	‘thermos, flask’
	káránfâf	‘crankshaft’
	kùnnî	‘quinine’
	ràfâlî	‘referee’

A handful of nonderived nouns have a Fall in initial position. The complete list is shown in (52). Newman conjectures that these are the result of the historical loss of a low-toned vowel.

(52) Hausa falling tone in nonderived words (initial):

bâmmí:	‘palm wine’
dâbgí:	‘anteater’ (< dá:bùgí: [dialect variant])
dùllú:	‘wild fig tree’
gâudzí:	‘fool, jester’ (< gá:wùdzí:)
gjàbdzí:/gjàzbi:	‘a rodent’ (< gjá:bùdzí:)
kùnné:	‘ear’
mânjá:	‘large (pl.)’
jâmmá:	‘afternoon, evening’

Falling tone is also found in initial syllable in derived words such as noun plurals, abstract nouns, frozen reduplicated nouns (e.g., *bêlbé:là:* ‘cattle egret’), grade 4 forms of certain monoverbs, a dozen grade 1 verbs, and a few exclamations (e.g., *jàuwá:* ‘bravo!’) (Newman 2000:607). This is due to the fact that most suffixes in Hausas are ‘tone integrating’ suffixes, which carry tonal melodies that override the tones of the base, and the tonal melodies associate from right to left (Newman 2000:600). This is likely the most productive right-to-left melody mapping documented in the literature. Examples in (53a) show the formation of class 4 plurals, which involves the reduplication of the base-final consonant, the suffixation of *-a:*, and a HLH tonal melody mapped from right to left; examples in (53b) show the formation of one type of abstract nouns, which uses a suffix *-ta:* and a HLH melody; examples in (53c) show the formation of certain grade 4 monoverbs, which employs a suffix *-nje* and a HLH melody; and examples in (53d) show the formation of certain disyllabic grade 1 verbs that behave as if they were trisyllabic and have a HLH melody.

(53) Hausa right-to-left mapping that creates initial Fall:

- | | | |
|----|--------------------------------------|-------------------------------|
| a. | Class 4 plurals: | |
| | bá:bè: / bâbbá: ‘locust’ | gá:gò: / gâggá: ‘pagan chief’ |
| | kú:ɾù: / kûɾɾá: ‘pony’ | ɾé:ʃè: / ɾâssá: ‘branch’ |
| b. | Abstract nouns: | |
| | mâitá: ‘witchcraft’ | wâutá: ‘foolishness’ |
| c. | Grade 4 monoverbs: | |
| | ʃá: ‘drink’ / ʃânjé: ‘drink up’ | tʃí ‘eat’ / tʃînjé: ‘eat up’ |
| | dʒá:jè: ‘pull’ / dʒânjé: ‘pull away’ | jí ‘do’ / jînjé: ‘complete’ |
| d. | Grade 1 verbs: | |
| | mântá: ‘forget’ | bâutá: ‘worship’ |
| | gjàɾtá: ‘repair’ | zântá: ‘converse’ |

The right-to-left mapping mechanism, or other tone-related processes, for that matter, does not create phonotactic violations in Hausa: Fall only surfaces on CVV, CVR, or CVO, and any Rise that develops due to syncope are simplified to either H or L depending on the context.¹³

Falling tone also occurs on word-medial syllables. For instance, the verbal noun forming suffix $\`-wá:$ creates a falling tone on the final syllable of the base provided it is heavy, as shown in (54a). When the $\`-wá:$ suffix is attached to a base that ends in a H-toned CV syllable, e.g., grade 7 verbs, the floating L is dropped, as shown in (54b).

(54) Hausa verbal nouns with suffix $\`-wá:$:

- | | | |
|----|--------------------------------------|-----------------|
| a. | kó:mó: + $\`-wá:$ → kó:mô:wá: | ‘returning’ |
| | káràntá: + $\`-wá:$ → káràntâ:wá: | ‘reading’ |
| | kó:jár + $\`-wá:$ → kó:jâr wá: | ‘teaching’ |
| | tsó:ɾátár + $\`-wá:$ → tsó:ɾátâr wá: | ‘frightening’ |
| b. | gjà:ɾú + $\`-wá:$ → gjà:ɾú wá: | ‘be repairable’ |
| | ʃà:wú + $\`-wá:$ → ʃà:wú wá: | ‘be drinkable’ |
| | dînkú + $\`-wá:$ → dînkú wá: | ‘be sewable’ |
| | ɾàsú ‘die’ + $\`-wá:$ → ɾàsú wá: | ‘death’ |

The examples in (51)-(54) indicate that contour tone restrictions in Hausa are determined by syllable type, not the linear position of the syllable in a prosodic domain. Bearing in mind that this is a language with clear right-to-left morphological melodies, it is somewhat striking that it does not have an initial

¹³ The two Rise simplification rules are: (a) LH → L /H ____; (b) LH → H elsewhere. E.g., gáwàjì: → *gáwàj´ → gáwàj ‘charcoal’; dʒímí:llà: → *dʒím´là: → dʒímlà: ‘total’. See Ch. 71, §1.2 of Newman (2000) for details.

preference for contour tones, as such preference is what one is led to expect if contour tone restrictions result from the mechanism of melody mapping. But the mystery goes away as soon as we disassociate contour tone restrictions from melody mapping. As I have argued, the licensing conditions of contour tones are best stated with respect to the duration and sonority of the rime, while the directionality of melody mapping is driven by the characteristics of processing, morphological directionality (prefixation vs. suffixation), or alternation. Therefore, it is not surprising that initial contour preference does not follow from right-to-left melody mapping.

5.2 Kanakuru

Kanakuru (Newman 1974) is another language for which right-to-left tonal melody mapping has been argued. It has two underlying tones H and L. There are occasional surface Falls, which I will come back to, and there is no Rise.

Kanakuru nouns, adjectives, and adverbs have two basic tonal melodies — H-H and H-L, and verbs also have two melodies — L-H and H-L. These melodies map onto words from right to left, as shown in (55a) and (55b).¹⁴ The directionality is clearly manifested in trisyllabic words with HLL and LLH tones. Monosyllabic words with H-L are sometimes simply pronounced with a L, e.g., tamɿ ‘silk cotton tree’, and sometimes pronounced with a slight fall, e.g., motɿ ‘oil’. Monosyllables with a L-H melody are pronounced with a H. The floating H or L at the beginning of these words may participate in tonal processes such as tone displacement or downstepping (Newman 1974).

(55) Kanakuru tonal melodies:

a. Nouns, adjectives, and adverbs

	σ	σσ	σσσ
H-H	dʒúŋ ‘black’ gái ‘spear’ lú ‘animal’	kúré ‘reedbuck’ néné ‘there’ gómék ‘corpulent’	gúmbáhlá ‘toad’ árijó ‘thorn’
H-L	ʔàk ‘knife sheath’ ʔàm ‘useless’ ʔà ‘cow’	kúrè ‘guinea corn’ néné ‘here’ wónò ‘yesterday’	támbálà ‘basket’ gúrúwù ‘storm’

¹⁴ All examples are from Newman (1974). Non-IPA symbols have been adapted to IPA according to Newman’s phonetic descriptions.

b. Verbs

	σ	σσ	σσσ
L-H	`kói ‘to catch’ `túi ‘to eat’	tùpé ‘to send’ ʃèní ‘to remember’	lùkùré ‘to disperse’ bìbìré ‘to crack’
H-L	´mòì ‘to wait for’ ´bòì ‘to shoot’	dápè ‘to collect’ gémì ‘to fill’	dzópólè ‘to tumble’ lápérè ‘to hold down’

Zoll (2003) argues against the melodic treatment of Kanakuru verbs by pointing out that the verb stems are bimorphemic, with the final *-i* or *-e* indicating verb class. Then the verbs can be analyzed as either L or H, with a suffix that assumes tonal polarity. But this analysis cannot be extended to nouns, adjectives, and adverbs, for which neither bimorphemicity nor tonal polarity can be argued.

Let us temporarily assume right-to-left melody mapping in Kanakuru. We notice that the tonal melodies in the language are not complicated enough to incur contour tones on syllables in di- or polysyllabic words. Therefore, on the surface, it looks like Kanakuru is not relevant for the point being made. But Kanakuru does allow falling tone. Newman (1974) lists a number of nonderived words with falling tone and also describes morphophonological processes that create Falls. Examples in (56a) are nonderived words listed in ‘Appendix 2 — Kanakuru-English Vocabulary’ of Newman (1974). Derived words with falling tone are exemplified in (56b).

(56) Kanakuru falling tone:

- a. báàm ‘useless’ mǎəm (< *mǎhəm) ‘hump on back’
 báàt ‘five’ ʃáà (< *ʃáhà) ‘war’
 méèn ‘beer’ táà (< *táhà) ‘shoe’
 kî (or kíjì) ‘boat, canoe’
- b. jí + àn → jíh ‘he used to...’
 past-continuous + suffix pronoun ‘he’
 jí + àm → jíh ‘we used to...’
 past-continuous + suffix pronoun ‘we’
 gám + î → gám + î ‘the ram’
 ram + definite marker
 tóró + î → tóròì ‘the farm’
 farm + definite marker
 dádáú + î → dádáwî ‘the game/play’
 game/play + definite marker

Although falling tone is a very limited phenomenon in Kanakuru, we can make the following generalizations regarding its surface occurrence: it only appears on word-final CVV(C) or CVR syllables (56a, b), and occasionally monosyllabic words. In other words, like Hausa falling tone, its licensing conditions are determined by syllable type, not the linear position of the syllable in

a prosodic domain. Therefore, the fact that contour tones do not preferentially surface in the initial syllable of a word in Kanakuru might be due to the simplicity of the tonal melodies to be mapped onto words, but there might be a deeper cause for the simplicity of tonal melodies: more complicated melodies would force contour tones to surface on syllables that have no durational advantage and are thus avoided.

There is still the issue whether tonal melodies are warranted at all in Kanakuru, especially in non-verbs. One can possibly analyze them as having a L vs. H contrast that is only licensed in word-final position, and the prefinal H's are filled in by default. But the crucial point here is that even if one were to acknowledge the existence of right-to-left melody mapping, initial contour tone advantage is still nowhere to be seen; this further motivates the disassociation between contour tone distribution and tonal melody mapping.

5.3 'Right-dominant' Chinese dialects

The avoidance of initial preference for contour tones can be motivated from a slightly different perspective in Chinese dialects. As I have mentioned briefly in §2.3.3, one way of classifying the many tone sandhi systems in Chinese dialects is by the dominant edge. 'Left-dominant' dialects include most northern Wu dialects like Shanghai, Suzhou, Changzhou, and others. Characteristically, the tone on the initial syllable of a compound is spread across the entire compound. This can be captured in OT with alignment and contour tone licensing constraints together with *LAPSE and *CLASH of Zoll (2003). 'Right-dominant' dialects include Min dialects like Fuzhou, Xiamen, Zhangzhou and southern Wu dialects like Wenzhou and Wenling. But the characteristic sandhi pattern for these dialects is not the leftward spreading of the tone on the final syllable; rather, the final tone is faithfully realized while the nonfinal tones level, reduce, and neutralize. This characteristic difference between left- and right-dominance is typified in Tangsic, whose left-dominant sandhi in adjective-noun compounds has been discussed in §2.3.3 — the data pattern is clearly left-to-right melody spreading. Tangsic, however, has right-dominant sandhi in verb-object compounds. The examples in (57) (all from Kennedy 1953) show that in disyllabic verb-object compounds, the final syllable preserves the original tone while the initial syllable has a neutralized level tone slightly lower than 33, which Kennedy writes as an 'S' and I have taken the liberty to transcribe as 22.

(57) Tangsic tone sandhi in verb-object compounds:

- a. T-33 → 22-33:
- | | | | |
|---------------------------|---|---------------------------|-------------|
| sao33-t ^h aŋ33 | → | sao22-t ^h aŋ33 | 'cook soup' |
| ma24-t ^h aŋ33 | → | ma22-t ^h aŋ33 | 'sell soup' |
| ma51-t ^h aŋ33 | → | ma22-t ^h aŋ33 | 'buy soup' |

- b. T-51 → 22-51:
 sao33-tsø51 → sao22-tsø51 ‘cooking wine’
 ma24-tsø51 → ma22-tsø51 ‘sell wine’
 ma51-tsø51 → ma22-tsø51 ‘buy wine’
- c. T-24 → 22-24:
 sao33-mie24 → sao22-mie24 ‘cook noodles’
 ma24-mie24 → ma22-mie24 ‘sell noodles’
 ma51-mie24 → ma22-mie24 ‘buy noodles’

The difference in tonal behavior between adjective-noun and verb-object compounds is apparent: it is not only in the location of neutralization, but also in the way in which neutralization happens. The left-dominant pattern instantiates left-to-right melody mapping, while the right-dominant pattern illustrates neutralization by merging to a common level tone, not right-to-left melody mapping. The neutralization in verb-object is apparently complete, as Kennedy comments on the inability of Tangsic speakers to distinguish ‘buy wine’ and ‘sell wine’ without sentential contexts.

The Wenzhou dialect of southern Wu (Zheng-Zhang 1964, Pan 1998), also known to be right-dominant, has a pattern similar to that of Tangsic verb-object compounds. Although Yue-Hashimoto (1987), in motivating the right-dominance of Wenzhou, claims that ‘the tonal contour itself is based on that of the last syllable. This means that the tonal contour of the last syllable spreads over the entire sandhi domain, just as in the case of the first-syllable dominant type’ (Yue-Hashimoto 1987:456-7), a careful look at the sound recording of Wenzhou sandhi in Pan (1998) indicates that the pattern is considerably more complex than can be summarized as right-to-left spreading.

Wenzhou has six lexical tones: 55, 31, 42, 22, 35, and 213.¹⁵ The two falling tones 31 and 42 differ not only in their average pitch, but also in the location of the turning point: 31 has a relative level portion at the beginning and then falls at the end; therefore a more accurate transcription should be 331. 42, however, starts the fall from the beginning of the tone. 213 is the so-called ‘Ru’ tone, which occurs on historical CVO syllables. But obstruent codas have been lost in modern Wenzhou except in nonfinal position of a word, where they are realized as glottalization at the end of the rime.

¹⁵The tonal transcriptions used here and the later sandhi table differ somewhat from Pan (1998). For example, Pan transcribes the high level tone as 33 instead of the 55 used here. This is done through careful examination of the sound recording instead of wishful thinking. The discrepancies between Pan’s transcriptions and the actual data might be due to the influence of Zheng-Zhang’s authoritative work on Wenzhou in 1964 — the phonetic tonal values might have changed during the past decades, yet the changes are not reflected in Pan’s newer work.

The disyllabic sandhi pattern of Wenzhou is summarized as in (58). We can see that the final syllable (σ_2) generally preserves its tone while the first syllable (σ_1) undergoes massive neutralization and simplification. For instance, tone 213, while occurring on σ_1 , simplifies to a level tone 22 irrespective of the tone on σ_2 , which is faithfully realized except in the case of 31; tones 35 and 213, when occurring on σ_2 , are always identically preserved while σ_1 in concatenation with them undergo neutralization. While the complete account of Wenzhou sandhi escapes us, especially when σ_2 has 31, 42, or 22, for our purpose it suffices to note that only when σ_2 is 31 or 42 could part of the disyllabic sandhi be possibly conceived as right-to-left spreading (42-21). Therefore, in contrast to Shanghai and adjective-noun compounds in Tangsic, Wenzhou constitutes another illustration of the difference between left- and right-dominance beyond directionality — melody mapping is far more relevant for the former.

(58) Wenzhou disyllabic tone sandhi:

$\sigma_1 \backslash \sigma_2$	55	31	42	22	35	213
55	55-55	22-13	22-42		42-35	35-213
31	33-55					
42	42-33	42-21	42-21	44-22	22-35	22-213
22						
35						
213	22-55	22-13	22-42	22-22	22-35	22-213

Without taking into account phonetic factors such as duration, the lack of right-to-left melody spreading in tonal alternation is surprising: unlike lexical melodies which canonically map left-to-right due to the lack of ALIGN-R (§4.2), sandhi tones CAN originate from the right and spread leftwards as there may exist highly ranked positional faithfulness constraints that value the preservation of tone on the final syllable. But if we take into account the durationally based licensing constraint *CONTOUR- σ_{nonfinal} , the left-right asymmetry now has an explanation: the right dominance effect is achieved by two kinds of faithfulness constraints MAX(tone)/final and IDENT(tone)/final, with the former preserving the final tone and the latter keeping the final tone on the final syllable; these faithfulness constraints do not conflict with contour tone licensing constraints such as *CONTOUR- σ_{nonfinal} , which means that the tone on the final syllable, contour or not, will be faithfully realized in-situ and has no need to spread leftward. The prevalence of tonal simplification in nonfinal positions is at this point no surprise to us — it is the direct result of the high-ranking of the durationally-based *CONTOUR- σ_{nonfinal} . Left dominance, however, enlists help from MAX(tone)/initial and IDENT(tone)/initial, whose satisfaction could potentially conflict with *CONTOUR- σ_{nonfinal} , and one way of resolving the conflict is to sacrifice IDENT(tone) and spread the initial melody rightward.¹⁶

¹⁶ A full picture of the directional asymmetries in Chinese tone sandhi systems is admittedly more complex than the description in this short section. But the generalization that the left-dominant sandhi is

5.4 Interim Conclusion

In this section, I have shown from two related perspectives that durationally based licensing constraints like *CONTOUR- σ_{nonfinal} are relevant for tonal grammars. First, for languages in which right-to-left melody mapping is motivated, we do not observe gravitation of contour tones to the initial syllable of the mapping domain. This supports the separation of contour tone licensing from the mechanism of melody mapping, as the initial syllable does not enjoy lengthening on a par with final lengthening and is thus not expected to be a preferred position for contour tones. Second, in contrast to the prevalence of left-to-right melody spreading in ‘left-dominant’ Chinese dialects, the scarcity of right-to-left spreading in ‘right-dominant’ dialects also indicates that *CONTOUR- σ_{nonfinal} is relevant to tonal grammars: the conflict between durationally based licensing constraints of this sort and initial faithfulness constraints provides a motivation for the initial tonal melody to spread rightward, but the lack of parallel conflict at the right edge predicts, correctly, that right-dominant dialects would not typically have right-to-left spreading, but nonfinal simplification and neutralization.

6. Final syllable preference or final tone preference?

Hyman (2004a, b) proposes another alternative to the final preference for contour tones. He argues that the lack of contour tones in nonfinal positions is due to the presence of a following TONE, not a following SYLLABLE, in the relevant domain. In other words, contour simplification is more appropriately captured by (59b) than (59a). Hence, the gravitation of contour tones to final position is not motivated by final lengthening, which only affects the final SYLLABLE in the domain. This is relevant to the present discussion since the core of the dispute is whether or not the contour licensing advantage should be stated with respect to position in a tonal melody. I summarize Hyman’s arguments below.

(59) Two different interpretations of nonfinal contour simplification:

a. Contour tones are simplified when followed by another syllable:



b. Contour tones are simplified when followed by another tone:



typically rightward spreading and the right-dominant sandhi typically involves default insertion and simplifying neutralization holds true nonetheless. Without taking the paper too farther afield, I discuss this issue fully in a separate work (Zhang 2006).

6.1 Luganda

Hyman's first argument comes from languages where a contour tone can be followed by a toneless syllable, but not a toned one. The identification of such a language would indicate that the licensing condition for contour tones depends on whether they are followed by another tone rather than another syllable. Hyman argues that Luganda exemplifies this pattern. There are two surface level tones — H and L — in Luganda. They can combine to form a HL falling tone provided that the syllable is bimoraic (CVV or CVC_g where C_g is the first half of a geminate consonant) (60a, b), or monomoraic (CV) in final position (60c) (Hyman, Katamba, & Walusimbi 1987, Hyman & Katamba 1990, 1993).

(60) Luganda falling tone distribution:

a.	mwáàná	'child'	kìjîkó	'spoon'	kùléetà	'to bring'
b.	mázzí	'water'	kîssí	'bait'	kúddá	'to return'
c.	mùsòtâ	'snake'	kìsikî	'log'	kùjâ	'to eat'

Hyman (2004a) further notes that the falling tone can only occur pre-penultimately on a bimoraic syllable if it is followed by lexical Ø; when it is followed by another lexical tone, it is leveled to H. Penultimately, however, bimoraic HL can occur before a lexical L or Ø. Examples in (61) illustrate these points. 'H%' or 'L%' indicates a boundary tone.

(61) Luganda falling tone leveling:

a.	a-léèt-èr-à	~	a-léèt-ér-á	'he brings to'
	HL L%		HL H%	
	a-léét-èr-à			'he who brings to'
	HL L L			
b.	a-léèt-à	~	a-léèt-á	'he brings'
	HL L%		HL H%	
	a-léèt-à			'he who brings'
	HL L			

Therefore, one generalization that can be made regarding Luganda falling tone is that it can occur on CVV provided that it is in penultimate position or it is the last tonal sequence in a word. Hyman goes on to argue that this is evidence for the relevance of being the final tone and the irrelevance of being on the final syllable to the advantage of contour tone licensing.

There are, however, languages in which it is the final syllable, not final tone, that provides advantage for contours. Beijing Chinese is one such example. Along with the four lexical tones 55, 35, 213, and 51 (§2.1.1), Beijing Chinese has another tone known as the neutral tone. Syllables carrying the neutral tone are often considered toneless, as their pitch realization is predictable from the context

in which they occur. Chao (1948, 1968) provides the following description for the realization of the neutral tone under different tonal environments:

(62) Phonetic realization of the neutral tone in Beijing Chinese:

Half-Low after 55:	t ^h aŋ tə.l	‘his’
Mid after 35:	ʂeŋ tə.l	‘whose’
Half-High after 21:	niŋ tə.l	‘yours’
Low after 51:	taŋ tə.l	‘big one(s)’

The crucial observation, however, is that the concave tone 213 is simplified to 21 before a toneless syllable, in parallel to its behavior before other toned syllables such as 55, 35, and 51. And this observation is corroborated by other studies such as Lin (1962, 1983) and Wang (1996). This indicates that the licensing condition for 213 is truly the final syllable in the word. A nonfinal 213 will simplify irrespective of whether the following syllable is toned or not.

Therefore, although the Luganda example indicates that there might be other non-durally-based conditions for contour tone licensing, the Beijing example shows that they are no REPLACEMENT for the final syllable condition, and the motivation for this condition — final lengthening — is hence still a relevant predictor for the distribution of contour tones.

6.2 Thlantlang Lai

Hyman’s second argument comes from the Thlantlang dialect of Lai spoken in Chin State of Burma. Thlantlang Lai has a vowel length contrast in closed syllables, and syllables can be closed by either a sonorant or an obstruent. Open syllables always have a long vowel. Therefore the syllable types in the language are CVV, CVR, CVVR, CVO, CVVO. There are three underlying tones — H, L, and HL. They participate in complicated sandhi patterns, whose complete analysis is not pertinent to the current discussion. But the relevant observation of the sandhi patterns is that surface contour tones HL and LH (which occurs in sandhi forms) are restricted to the final position of the sandhi domain. Hyman argues that this is not due to the durational advantage of the final syllable however, as nonfinal long-voweled syllables such as CVV and CVVR are bound to be longer than final CVO, but the latter can carry surface HL and LH, while the former cannot. Therefore, the restriction of surface contours to final position cannot be predicted on the basis of duration, but can be predicted on the basis of simply being the final tone.

Zhang (2002) in fact discusses two languages — Lama (Ourso 1989) and Kɔnni (Cahill 1999) — that behave similarly to Thlantlang Lai. In both languages, contour tones are banned from nonfinal syllables in a word even when they have a [+long] vowel, but are allowed on final syllable even if it has a [-long] vowel. But Zhang (2002) argues that these languages do not necessarily present a problem for

the durational approach to contour tone distribution. I recapitulate the argument here, in the hopes that it will shed light on the Thlantlang Lai data.

The legality of a falling contour HL on a final short vowel and the avoidance of the same contour on a nonfinal long vowel in Lama is evidenced by examples in (63a) and (63b) respectively. Data in (63c) further illustrate the avoidance of HL on a nonfinal short vowel. The underdot indicates that the vowel is [-ATR].

(63) HL distribution in Lama:

- a. HL on final CV:
cénṭi ‘friend’ nàṭṭa ‘mouse’
- b. No H̄L on nonfinal CVV:
náà ‘cow’ tḗ ‘under’ tḗ ‘chez’
náá tḗ ‘under cow’ náá ṽtḗ ‘chez cow’
- c. No HL on nonfinal CV:
cénṭi ‘friend’ nâ Noun Class 2 suffix cénṭi ṽnâ ‘friends’

The intuition in Zhang (2002) is that a nonfinal HL can be manifested by other means, such as downstepping the following H, or realizing the L tone on the following syllable, but a final HL does not have such options. If in the grammar, the constraint that requires the realization of tones — in one way or another — is undominated, then a final HL will have to surface as such even when the syllable has a short vowel, while a nonfinal HL does not have to surface on the syllable from which it was originated, even when the syllable has a long vowel. Thus the avoidance of HL on nonfinal long vowels is due to the general dispreference for contour tones and does not require a reversal of the durationally determined licensing scale. To formalize the intuition, let us posit the constraints in (64).

(64) Constraints for Lama:

- a. REALIZE-HL: realize the HL contour in some fashion.
- b. *HL- $\sigma_{\text{final-V}}$: no HL contour on a final short vowel.
- c. *HL- $\sigma_{\text{nonfinal-VV}}$: no HL contour on a nonfinal long vowel.

REALIZE-HL is satisfied under the following three situations: (a) the HL contour is preserved on the original syllable; (b) the HL contour is simplified to H, and it is immediately followed by an underlying H which surfaces as [!]H, LH, or L; and (c) the HL contour is simplified to H, and it is immediately followed by an underlying L which surfaces as L. The legitimacy of (c) lies in the assumption that the actual realizations of underlying HL-L and H-L are different, despite the fact that they are both transcribed as H-L. The justification for the assumption comes from phonetic studies that show that the peak of a High tone is usually realized on the syllable following its carrier (Xu 1997, 1998, 1999, Meyers 1998, Kim 1999). Therefore, it is plausible that the actual realizations of underlying HL-L and H-L sequences differ in timing: the f_0 peak is realized later in the latter than in the

former. Thus the underlying HL-L and H-L sequences are kept distinct. The markedness constraints in (64b) and (64c) ban the HL contour on a final short vowel and a nonfinal long vowel respectively.

Under the assumption that the canonical duration of a nonfinal long vowel is longer than that of a final short vowel, the intrinsic ranking of the tonal markedness constraints is $*HL-\sigma_{\text{final-V}} \gg *HL-\sigma_{\text{nonfinal-VV}}$. But if REALIZE-HL is ranked above both these constraints, the tonal pattern in Lama can be derived, as shown in (65).

(65) Tableaux for Lama:

a. $\text{cén}\grave{\text{t}}\grave{\text{i}} \rightarrow \text{cén}\grave{\text{t}}\grave{\text{i}}^{17}$

	cén $\grave{\text{t}}\grave{\text{i}}$	REALIZE-HL	$*HL-\sigma_{\text{final-V}}$	$*HL-\sigma_{\text{nonfinal-VV}}$
☞	cén $\grave{\text{t}}\grave{\text{i}}$		*	
	cén $\grave{\text{t}}\grave{\text{i}}$	*!		
	cén $\grave{\text{t}}\grave{\text{i}}$	*!		

b. $\text{nàà t\grave{e}} \rightarrow \text{náá t\grave{e}}$

	náá t \grave{e}	REALIZE-HL	$*HL-\sigma_{\text{final-V}}$	$*HL-\sigma_{\text{nonfinal-VV}}$
☞	náá t \grave{e}			
	nàà t \grave{e}			*!
	náá t \grave{e}		*!	

c. $\text{nàà t\grave{e}} \rightarrow \text{náá } \grave{\text{t}}\grave{\text{e}}$

	náá $\grave{\text{t}}\grave{\text{e}}$	REALIZE-HL	$*HL-\sigma_{\text{final-V}}$	$*HL-\sigma_{\text{nonfinal-VV}}$
☞	náá $\grave{\text{t}}\grave{\text{e}}$			
	nàà t \grave{e}			*!

In (65a), HL must be realized on the final syllable, as any simplification will incur a violation of REALIZE-HL. In (65b), if the L on the final syllable is considered the result of the merger of the L part of the HL and the original L of the final syllable, and the surface result is distinct from that of an underlying H-L sequence, then the falling contour is in fact realized in the winning candidate, even though it does not have a surface HL in its transcription. The winning candidate of course violates other faithfulness constraints such as IDENT(tone), but they are too lowly ranked to show an effect. In (65c), the winning candidate realizes the HL by downstepping the following H, and at the same time avoids the surface HL. From these tableaux, we can see that the ranking $*HL-\sigma_{\text{final-V}} \gg *HL-\sigma_{\text{nonfinal-VV}}$, which projects from the phonetic assumption that a nonfinal long vowel is longer than a

¹⁷ Oruso (1989) treats the UR of $\text{cén}\grave{\text{t}}\grave{\text{i}}$ as $\text{cent}\grave{\text{i}}$. The High on the first syllable and the Fall on the second

|
H L

syllable are derived via the Association Conventions and the Wellformedness Condition. Given that I specifically argue against these notions, I treat the UR as prelinked for tones.

final short vowel, does not in fact make the wrong prediction about the output of the grammar. Therefore, the relevance of duration to contour tone distribution has not been disproved by the Lama example. The point of this discussion is not to show that the kind of contour tone distribution in languages like Lama, Kɔnni, and Thlantlang Lai is exactly predicted by syllable duration, but that it does not necessarily contradict the predictions made by the universal ranking in the durationally based theory — $*HL-\sigma_{\text{final-V}} \gg *HL-\sigma_{\text{nonfinal-VV}}$, and hence does not constitute a disproof of the theory, as claimed by Hyman (2004a, b).

Further support for this interpretation of the Thlantlang Lai data can be found in the disyllabic sandhi pattern given in (66) (Hyman 2004b). We can see that when HL occurs nonfinally, the L is always realized on the following syllable.

- (66) Thlantlang Lai disyllabic tone sandhi:
- a. HL-HL → H-LH: ráál-zòónj ‘enemy’s monkey’
 - b. HL-H → H-LH: ráál-vők ‘enemy’s pig’
 - c. HL-L → H-LH:¹⁸ ráál-rǎŋ ‘enemy’s horse’

6.3 Additional arguments in favor of the durational approach

Another criticism of Hyman’s approach lies in its lack of motivation either phonetically or psycholinguistically. The ‘final syllable’ approach bases itself on the peculiar durational property of prosodic-final syllables; therefore, we would not expect to have constraints that are otherwise comparable, but prefer contour tones on the initial syllable, to play a comparable role in the grammar. The ‘final tone’ approach, however, rids itself of this motivation; thus a reasonable conjecture would be that comparable constraints that favor contour tones as the initial or any other tone to be just as likely to exist in the grammar and have their effects manifested. This, we know, is not the case. Zhang (2002)’s survey discovers no language that has an initial preference for contour tones when all else is equal — a fact predicted by the ‘final syllable’ approach, but not the alternative.

Relatedly, Zhang (2002) has also shown that, unsurprisingly, contour tones are more likely to occur on long-voweled and stressed syllables: out of the 187 languages surveyed, contour tones occur more freely on CVV(C) than CV(C) in 38 languages and more freely on stressed syllables than unstressed ones in 22 languages. Similar observation has also been made by Duanmu (1990, 1994a, b) and Yip (1989, 1995). Like prosodic-final syllable and syllables in shorter words, these privileged licensors of contour tones also have a long duration: phonologically [+long] vowels are by definition longer than [-long] vowels; and stressed vowels are also crosslinguistically known to be longer than unstressed vowels (e.g., Fry 1955, Lieberman 1960, Morton & Jassem 1965, Adams & Munro 1978 for English; Jassem 1959 for Polish; Simoes 1996 for Spanish; de

¹⁸ The final H target here is due to a rule that changes L to LH prepausally, as posited by Hyman.

Jong & Zawaydeh 1999 for Arabic). Therefore, the durational account unifies the contour licensing conditions by an independently observable phonetic property while the ‘final tone’ account loses this generalization. I take this as another advantage of the former over the latter.

7. Conclusion

I have argued in this paper that properties of contour tone distribution are not the artifact of tonal melody mapping. The main argument is in the generality of the account of the phenomena: a durationally based approach unites not only different privileged licensers for contour tones, but also different types of languages in which tonal melodies may or may not be justified. Another point of comparison that favors the durational approach is in the account of the lack of contour tone advantage in initial position. This falls out directly from the durational approach as the initial position does not benefit from the degree of lengthening afforded by the final position, but it has to be arbitrarily posited by alternatives. Finally, in Optimality Theory, the privilege of prosodic-final position for contour tone bearing must be separately posited in addition to the alignment constraints to simulate the melody mapping mechanism in serial derivation. This further supports the independence of contour tone distribution from melody mapping, even if it can be motivated in the language in question.

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